APPENDIX E

TECHNICAL METHODOLOGIES AND KEY DATA

E-1 SOCIOECONOMICS

E-1.1 Methodology and Key Assumptions for Socioeconomics

The socioeconomic impact analysis evaluates both the impacts on regional economic activity, as measured by changes in employment and earnings, and the impacts on communities surrounding Idaho National Engineering and Environmental Laboratory (INEEL), as measured by changes in population and the demand for housing and public services. The study area comprises a seven-county Region of Influence (ROI) and socioeconomic impacts are estimated for each of the proposed Advanced Mixed Waste Treatment Project (AMWTP) alternatives. The methodology employed for the AMWTP Environmental Impact Statement (EIS) is similar to that used in the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Program Final Environmental Impact Statement* (DOE INEL EIS) (DOE 1995), but includes updated data and a revised version of the Regional Input-Output Modeling System (RIMS II).

Socioeconomic impacts are addressed in terms of both direct and indirect impacts. Direct impacts are changes in INEEL employment and earnings expected to take place under each alternative and include both construction and operations phase impacts. Indirect impacts are the effects on regional economic activity that result form changes in U.S. Department of Energy (DOE) purchases of goods and services within the region expected to occur under any of the alternatives. The total economic impact to the ROI is the sum of direct and indirect effects. Both the direct and indirect effects were estimated for the ROI described in Section 4.3, Socioeconomics.

The direct impacts estimated in the socioeconomic analysis are based on project summary data developed by DOE in cooperation with INEEL contractors and their representatives. Direct employment impacts represent actual increases or decreases in INEEL staffing; they do not include changes in staffing due to reassignment of the existing INEEL workforce. Total employment and earnings impacts were estimated using RIMS II multipliers developed specifically for the INEEL ROI by the U.S. Bureau of Economic Analysis (BEA 1997). The construction activities were represented by the New Construction, Maintenance, and Repair Industry, while operations activities were represented by the Industrial Inorganic and Organic Chemicals Industry.

The significance of the actions and their impacts is determined relative to the context of the affected environment. Projected baseline conditions in the ROI, as presented in Section 4.3, Socioeconomics, provides the framework for analyzing the significance of potential socioeconomic impacts that could result from implementation of any of the alternatives. Baseline employment and population represent socioeconomic conditions expected to exist in the ROI through the year 2025. Each alternative, other than the No Action Alternative, is expected to generate short-term increases in employment and income as a result of construction, as well as longer term increases as a result of operations.

E-1.2 Population, Housing, and Community Services

Population changes associated with the projected baseline conditions and the proposed alternatives are an important determinant of other social economic and environmental impacts. These population changes have three key components: (1) baseline growth, (2) relocation of workers and their dependents, (3) natural increase of population over the long term.

Because of the small size of the workforce associated with each of the AMWTP alternatives, the socioeconomic impact analyses assumed that all jobs could be filled by available workers currently residing in the ROI. The assumption was based on the types and number of jobs that would be required to implement each of the proposed alternatives, the composition of the work force currently residing in the ROI, and projected unemployment rates. Even if a small proportion of the required workforce were to migrate in from other regions, the number would be to small to have an effect on demographics and the housing market. Similarly, there would be no perceptible increase in demand for public services.

E-1.3 Key Assumptions

- The baseline workforce is assumed to be non-construction related.
- Construction and operations employment were assumed to be newly created jobs for all the alternatives.
- Construction staffing was based on project descriptions. Impacts were assessed for the peak year of construction.
- Operations staffing was based on project descriptions and assumed to be per year for the life of the project.
- Operations and construction staffing requirements could be filled by available workforce currently residing in the ROI.
- Wages for operations workers were based on project descriptions. An average wage of $26,286 was assumed for construction employees (Census 1997).
- The projected population trends for the ROI assume continuation of current operations at INEEL. The forecasts assumed a stable workforce through the year 2025.

E-2 GEOLOGY AND WATER

This section describes the methodology used to support the conclusions regarding the geologic hazards at the INEEL and local and regional water resources impacts for the four alternatives evaluated in this environmental impact statement. These conclusions resulted from an extensive review of existing documentation characterizing the geologic and hydrological conditions at the INEEL and a compilation of this material into a concise description of the existing conditions and potential impacts. This portion of Appendix E directly supports the summaries presented in Sections 4.6 and 5.6 (Geology) and 4.8 and 5.8 (Water Resources.)

E-2.1 Geology

The evaluation of geology at the INEEL site focused on the geologic hazards that could potentially impact the Radioactive Waste Management Complex (RWMC) and AMWTP project site. The following section discusses the studies used to determine the magnitude and likelihood of the hazards associated with seismicity and volcanism at the AMWTP project site.

E-2.1.1 Seismicity

The INEEL is located on the eastern Snake River Plain. The Snake River Plain extends in a broad arc from the Idaho-Oregon border on the west to the Yellowstone Plateau on the east. The plain varies in width from about 50 to 60 miles and is over 370 miles long (Figure E-2.1.1-1).

The mountains surrounding the eastern Snake River Plain are composed mostly of much older rocks (100 million to 600 million years) that were folded by compression forces about 60 million years ago. Starting about 17 million years ago and continuing today, extensional forces on these same rocks caused faulting (Link et al. 1988 and Pierce and Morgan 1992). The failure produced long north-to northwest-trending mountain ranges that extend both north and south from the margins of the eastern Snake River Plain. Those that extend north (the Lost River, the Lemhi Range, and the Beaverhead Range) are each bounded along their western sides by large active faults that are capable of generating earthquakes of magnitude 7 or slightly greater. The south ends of these faults lie very close to the western and northern boundaries of the INEEL and are the major sources of seismic hazards for INEEL facilities.

The largest recorded earthquake in the vicinity of the INEEL was the 1983 Borah Peak earthquake. This 7.3 earthquake, occurred on the middle portion of the Lost River Fault near the towns of Mackay and Challis, about 50 miles from INEEL. Peak horizontal accelerations ranged from 0.022 to 0.078g at the INEEL site from the Borah Peak earthquake (Jackson 1985). Another large earthquake, the Hebgen Lake earthquake (magnitude 7.5), occurred in 1959 on the Yellowstone Plateau about 125 miles from INEEL. No damage to INEEL facilities resulted from either earthquake (Jackson & Boatwright 1987).

Both of these earthquakes occurred within a parabolic zone of historic recorded seismicity and young faults (Figure E-2.1.1-1). This zone passes through the Yellowstone Plateau and flanks the eastern Snake River Plain (Andres et al. 1989). However, the INEEL seismic network and other networks show that the eastern Snake River Plain and adjacent parts of nearby mountain ranges form a zone of seismic inactivity or relatively low seismic activity inside the seismically active parabolic zone. During the 25 or more years of earthquake monitoring by the INEEL seismic network, only a few microearthquakes (magnitude less than 1.5) have occurred on or near the INEEL site (Jackson et al. 1993). Studies of the southern ends of the lost River and Lemhi faults near the towns of Arco and Howe show that earthquakes as large as the Borah Peak earthquake occurred there most recently about 20,000 years age (Woodward-Clyde 1992b,1995)

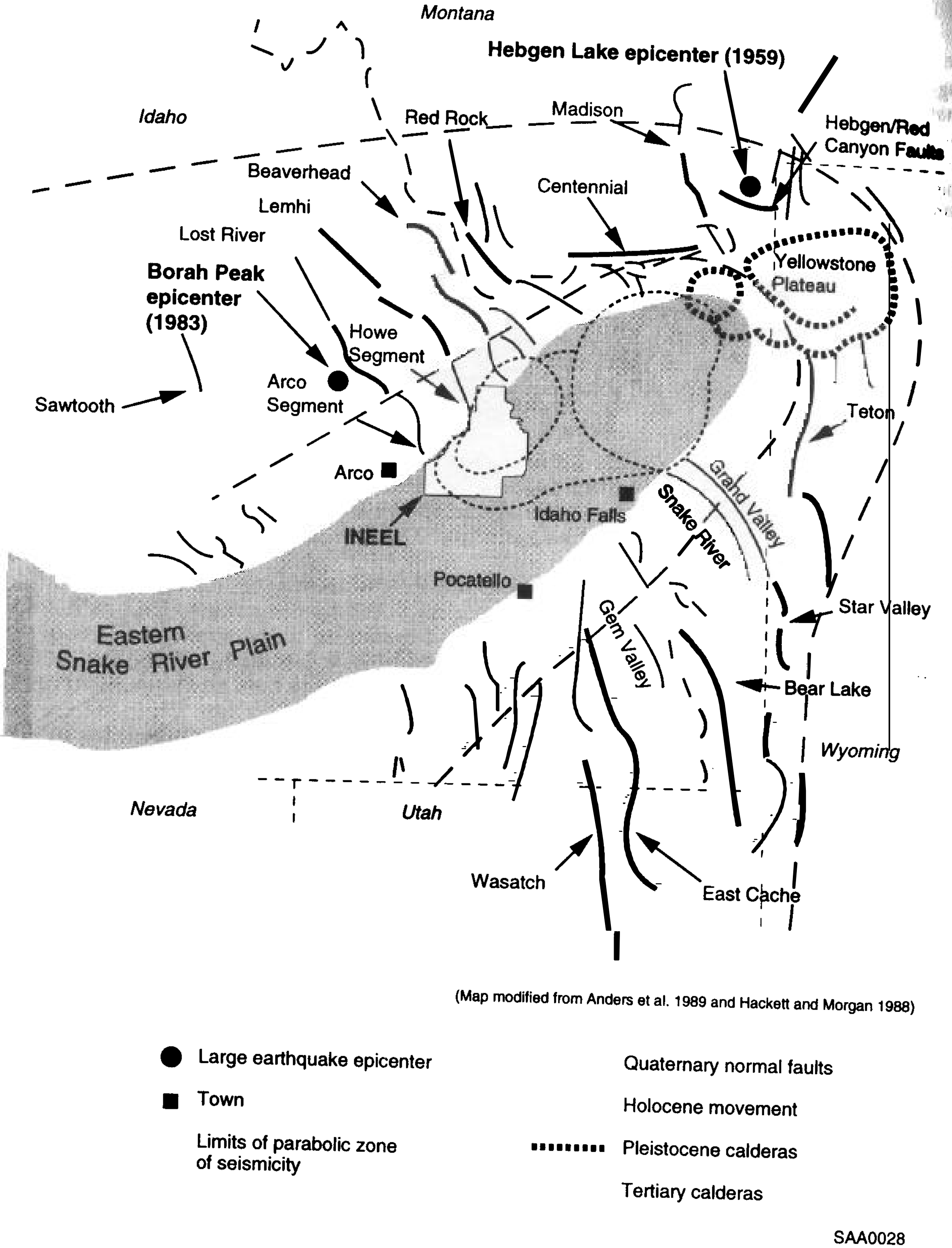

Figure E-2.1.1-1. Geologic features in the region of the INEEL.

For purposes of siting new facilities within the INEEL, a series of seismic hazard maps have been generated (Smith 1995). These maps show the levels of ground motion to be expected at various return periods using contour lines. The seismic hazard maps for return periods of 500 and 2000 years are shown in Figures E-2.1.1-2 and E-2.1.1-3, respectively. The contoured ground motions can be used for site selection purposes and as a general guide to the level of seismic hazard but not for design of facilities. The design of facilities must incorporate site-specific investigations.

A Site-Specific Probabilistic Seismic Hazard Analyses for the Idaho National Engineering Laboratory (INEL) (Woodward-Clyde 1996) was prepared using the results of the fault studies and other recent geologic and seismologic studies to determine the levels of ground motion to be expected at INEEL facilities (Woodward-Clyde 1996).

Figure E-2.1.1-4 shows the contribution of the three main source types to the mean hazard at the RWMC. The volcanic rift zones (VRZs) contribute very little to the total hazard compared to the regional source zones and the fault sources. The relative contributions of the fault sources increase as one considers longer period motions because of the increased effect of magnitudes on ground motion levels at longer periods, resulting in an increased domination of the hazard by larger magnitude events. The fault zones are expected to have higher frequency of large magnitude events and the largest maximum magnitudes compared to the nearby regional source zones.

Figure E-2.1.1-5 shows the relative contribution of the three fault sources at the RWMC. The Lost River fault contributes the most hazard because of its proximity and its relatively higher recurrence rates than the other two faults.

Figure E-2.1.1-6 shows the contribution to the mean hazard from the volcanic sources at the RWMC. The volcanic sources have minimal contribution to the RWMC site hazard because of their low activity rates and, in the case of the postulated Howe-East Butte zone, the low likelihood that it represents a distinct seismic source. The contribution to the seismic hazard from the various regional source zones at the RWMC is shown in Figure E-2.1.1-7. The northern Basin and Range source zone is the controlling regional source zone because of its proximity to the INEEL and its relatively high rate of seismicity compared to the eastern Snake River Plain. The eastern Snake River Plain source contributes to the hazard at very low probability levels

E-2.1.2 Volcanism

The most significant volcanic hazard to INEEL facilities is basaltic volcanism, since it has occurred more recently, has covered more area, and has the potential to occur nearer INEEL facilities. Geologically young volcanic activity in the INEEL area consists of eruption of basalt lava flows and the building of rhyolite domes (Kuntz et al. 1992). Basalts exposed at the surface of the INEEL range in age from over 1 million years to about 12,000 years. Basalts a few miles away from the INEEL at Hell's Half Acre lava field are about 5,000 years old. At Craters of the Moon National Monument a few miles to the west of the INEEL, the basalts are as young as 2,000 years. The vent areas for basaltic lava flows are not randomly distributed on the eastern Snake River Plain but are concentrated in elongate northwest-trending volcanic rift zones and along the Axial Volcanic Zone (Figure E-2.1.2-1). Rhyolite domes occur along the axis of the plain at the Big Southern Butte (30,000 years old), and East Butte (600,000 years old), and probably the Middle Butte (age unknown).

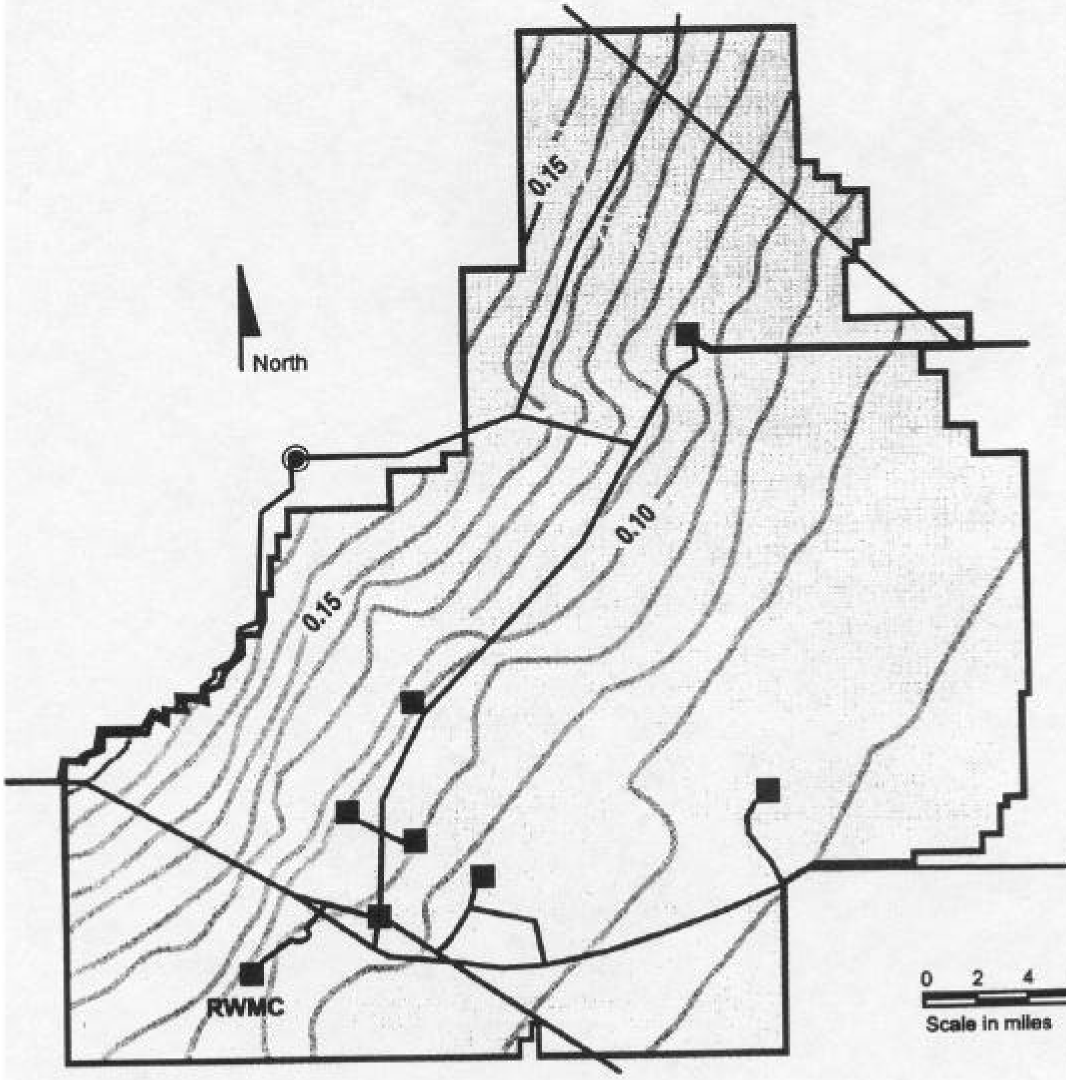

Figure E-2.1.1-2. Seismic hazard map for a return period of 500 years.

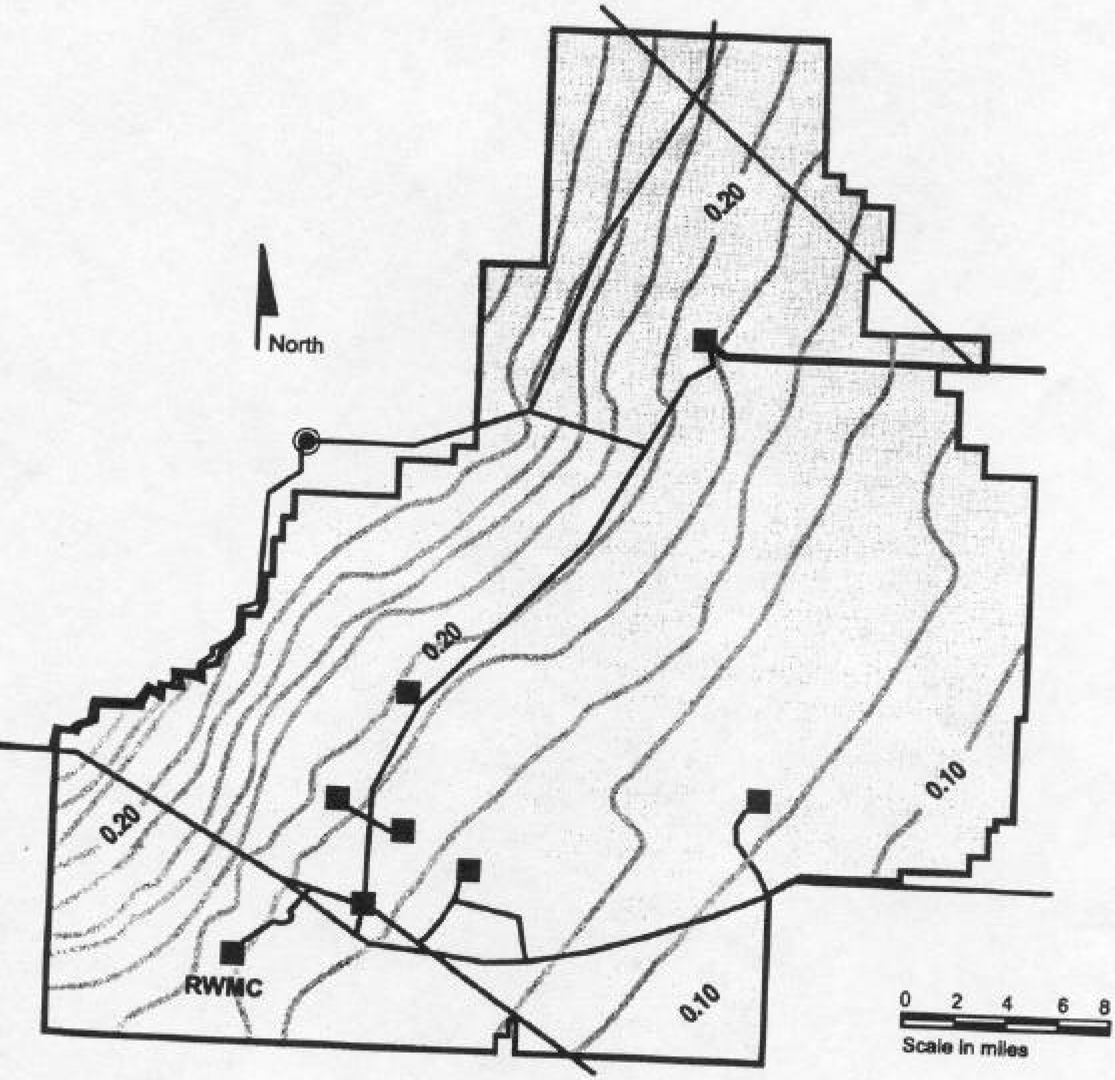

Figure E-2.1.1-3. Seismic hazard map for a return period of 2000 years.

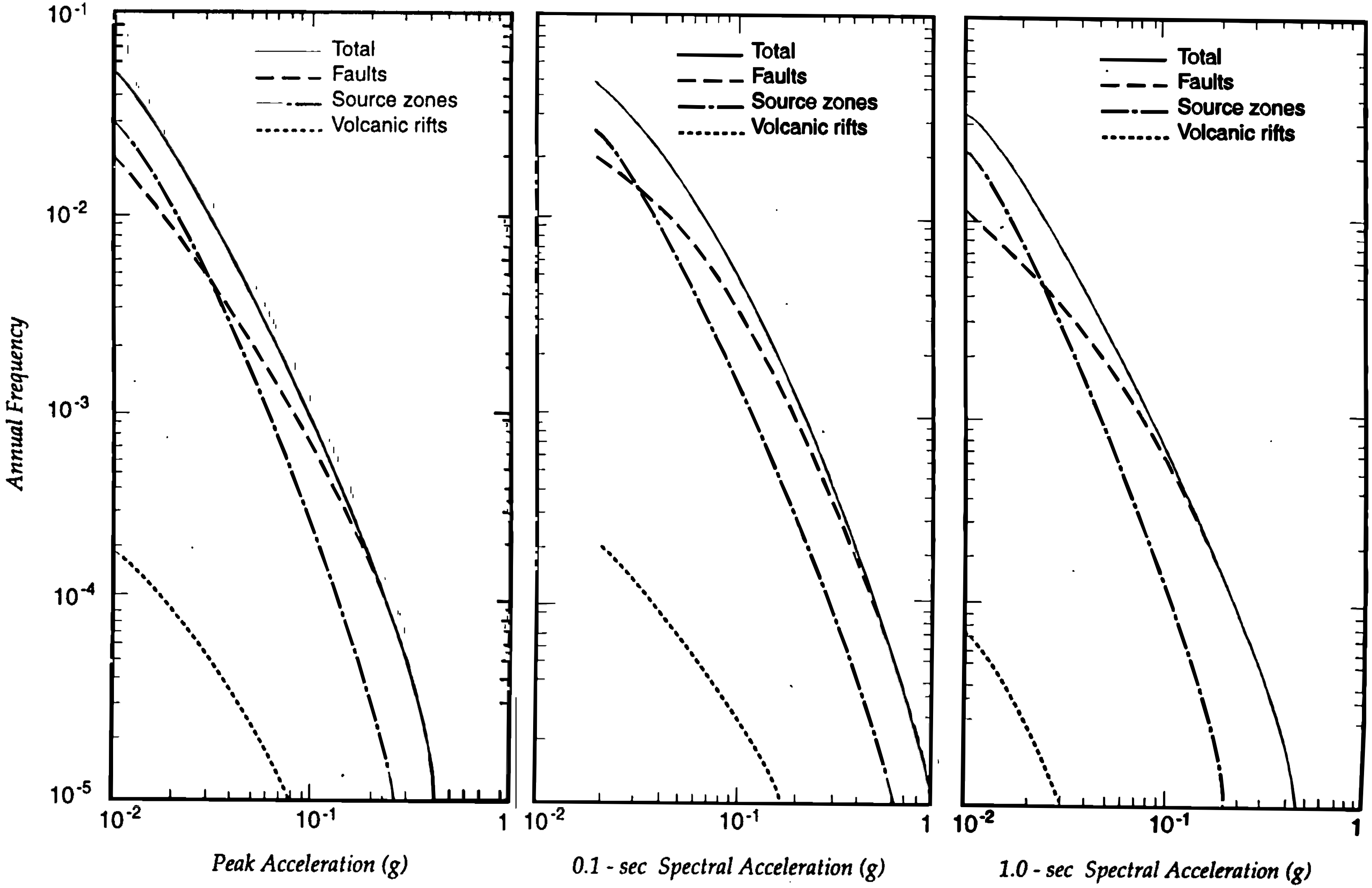

Figure E-2.1.1-4. Contributions of the seismic sources to the mean seismic hazard at RWMC.

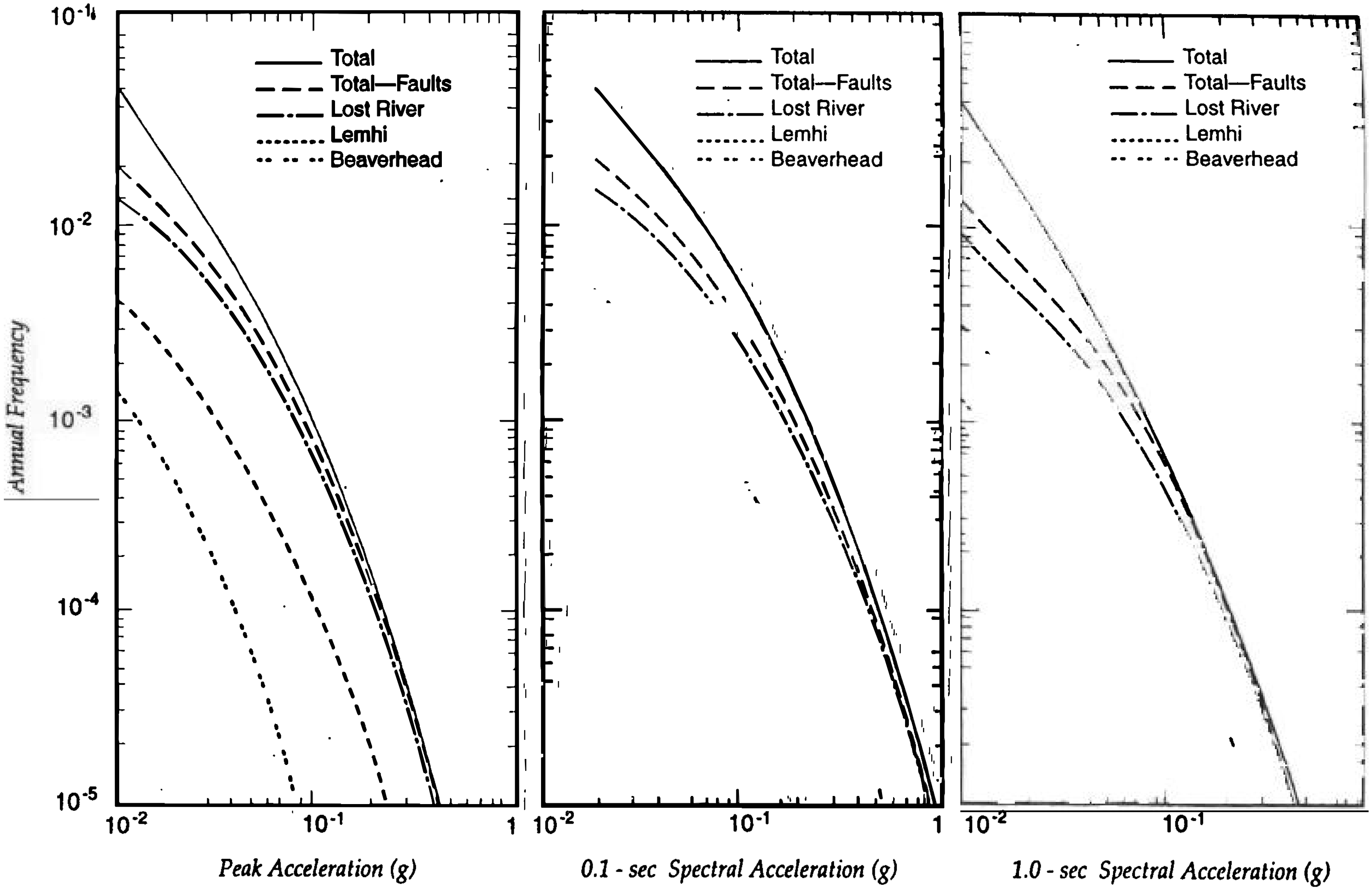

Figure E-2.1.1-5. Contributions of the fault sources to the mean seismic hazard at RWMC.

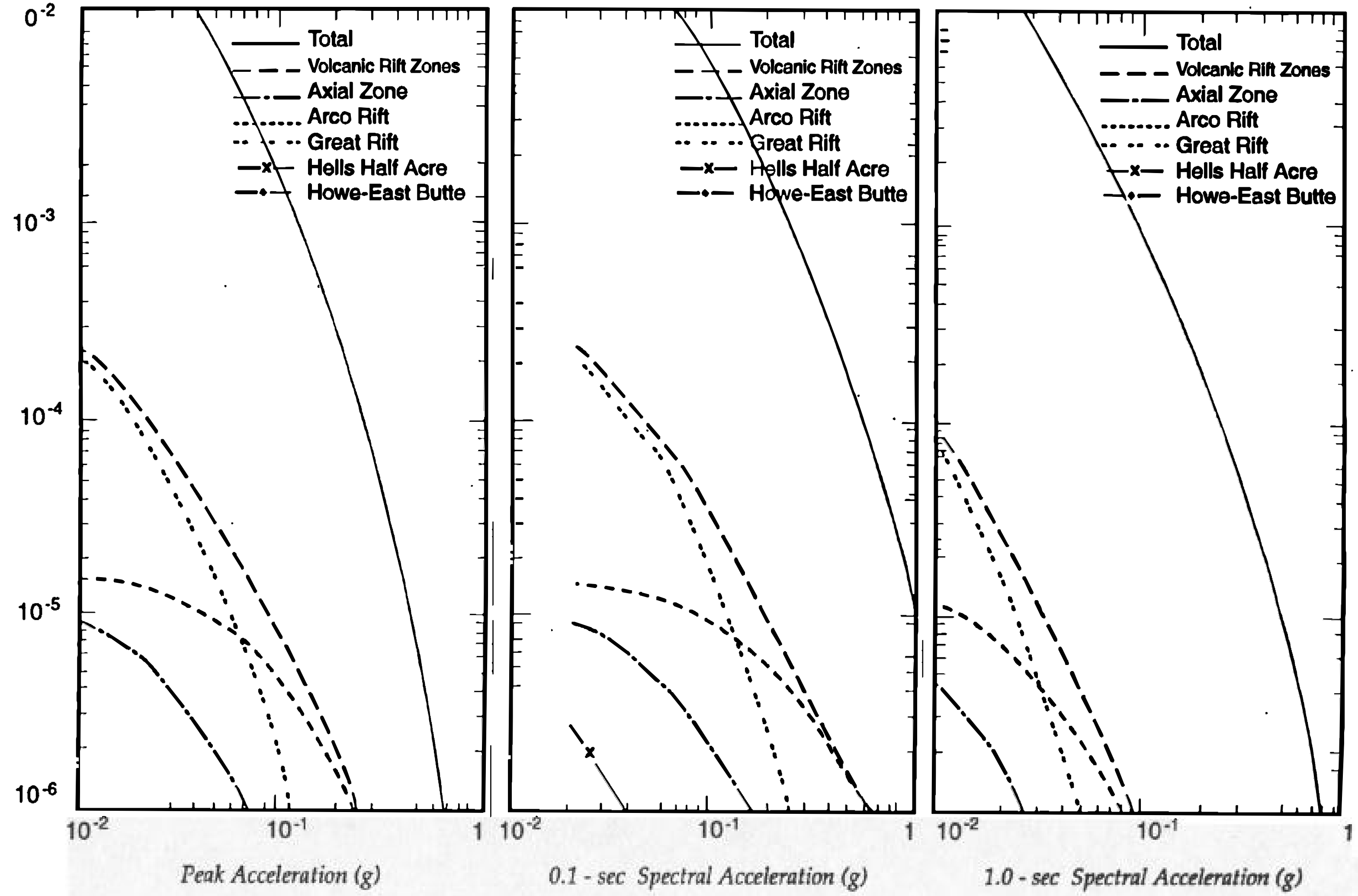

Figure E-2.1.1-6. Contributions of the volcanic sources to the mean seismic hazard at RWMC

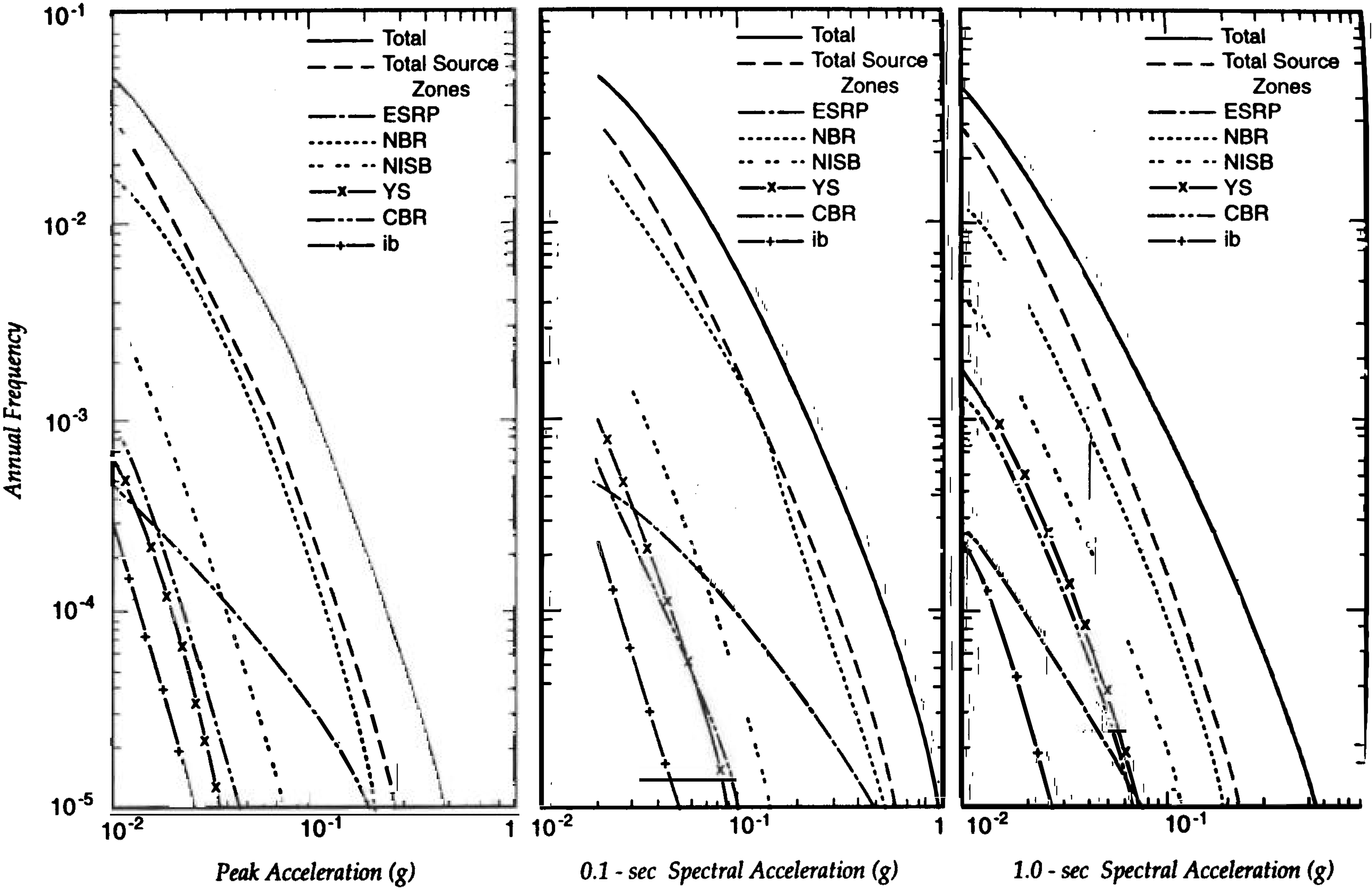

Figure E-2.1.1-7. Contributions of the regional source zones to the mean seismic hazard at RWMC.

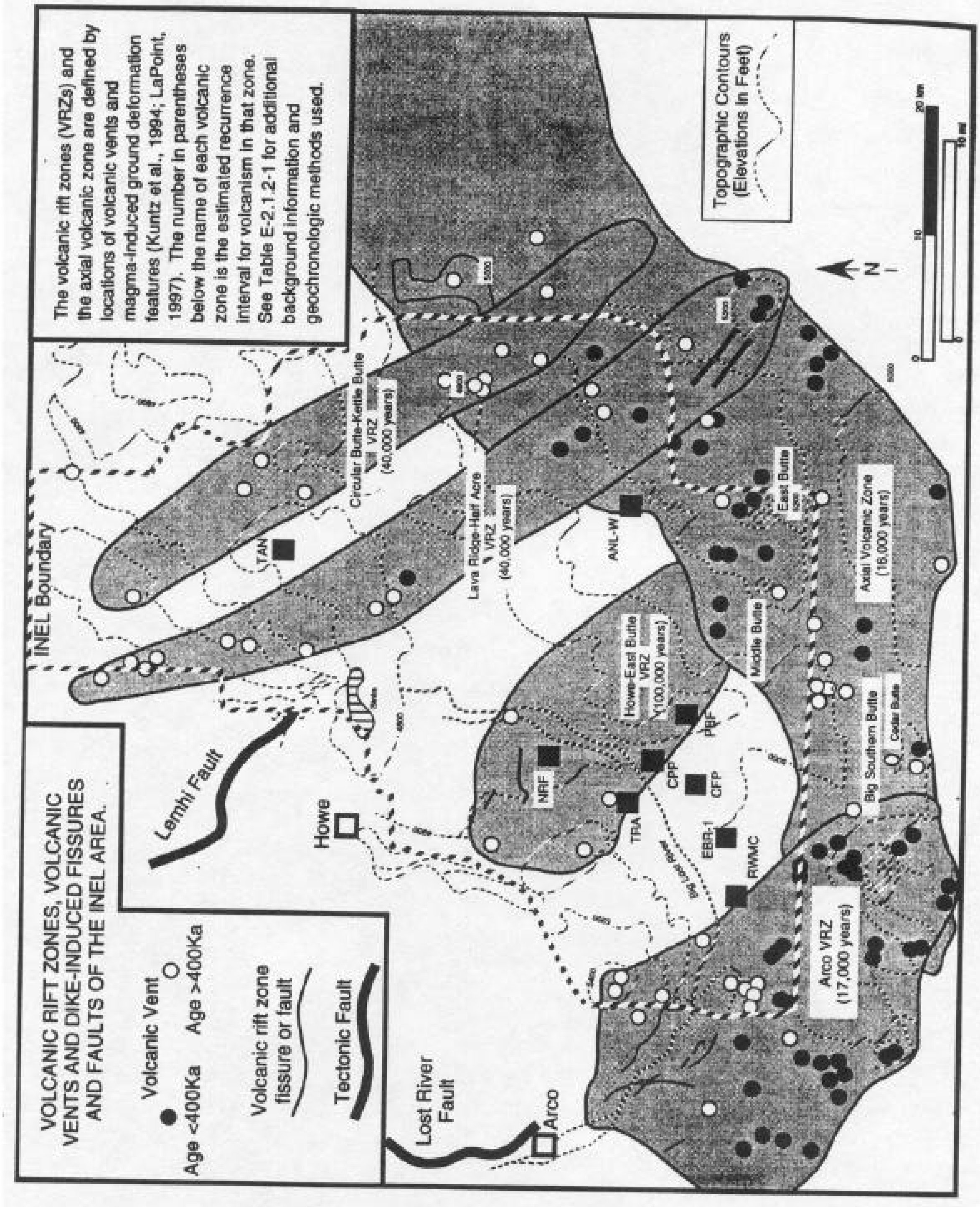

Figure E-2.1.2-1. Map showing volcanic vents and volcanic recurrence intervals for volcanic zone in the INEEL region.

Table E.2.1.2–1. Estimated volcanic-recurrence intervals and corresponding annual eruption probabilities (in parentheses) for volcanic zones and boreholes of the INEEL area.

Volcanic zone or borehole	Data sources	Time interval of volcanism	Number of vents fissures or flow groups	Comments	Estimated recurrence interval
Great Rift (25 km southwest of INEEL)	Kuntz et al., 1986, 1988	2,100 - 15,00 yrs (radiocarbon dating)	> 100 vents; 8 Holocene eruptive periods (each lasting a few decades or centuries, and each including multiple flows and cones)	No impact on INEEL; most recently and frequently active of all Eastern Snake River Plain rift zones; thus provides minimum recurrence for entire Eastern Snake River Plain; most probable area of future Eastern Snake River Plain volcanism	2,000 yrs ($5x10^{-4}$/yr)
Axial Volcanic Zone (southern INEEL)	Kuntz et al., 1986, 1994	5,000 - 730,000 yrs K-Ar dating; radiocarbon; paleomagnetic data)	73 vents & fissure sets; Holocene lava fields, 3 of them shared by VRZs. 45 cogenetic vent/fiss gps	Could affect much of southern INEEL; most recently and frequently active of all volcanic zones that could impact INEEL	16,000 yrs ($6.2x10^{-5}$ /yr)
Arco VRZ (southwestern INEEL)	Kuntz, 1978; Smith et al., 1989; Kuntz et al., 1994	10,000 - 600,000 yrs (radiocarbon, K-Ar and TL dating; paleomagnetic data)	83 vents & fissure sets; 2 Holocene lava fields. 35 cogenetic vent/fiss gps	Volcanism could affect southwestern INEEL	17,000 yrs ($5.9x10^{-5}$ /yr)
Lava Ridge-Hells Half Acre VRZ (Includes Circ Butte/kettle Butte volc rift zone) (north & eastern INEEL)	Kuntz et al., 1986, 1994	5,000 - 1,200,000 yrs (K-Ar dating; radiocarbon; paleomagnetic data)	48 vents & fissure sets; 1 Holocene lava field: Hells Half Acre. 30 cogenetic vent/fiss gps	Could affect northern & eastern INEEL; extremely long eruptive history; includes oldest and youngest basalts in the INEEL area	40,000 yrs ($2.5x10^{-5}$ /yr)
Howe-East Butte Volcanic Rift Zone (central INEEL)	Kuntz, 1978, 1992; Golder Associates, 1992	230,000 - 730,000 yrs (K-Ar dating; paleomagnetic data)	7 vents & fissure sets; no Holocene features. 5 cogenetic vent/fissure groups	Old, poorly exposed and sediment-covered; identified in part by subsurface geophysical anomalies	100,000 yrs ($1.0x10^{-5}$ /yr)
Borehole NPR SITE E (south-central INEEL)	Champion et al., 1988	230,000 - 640,000 yrs (K-Ar dating; paleomagnetic data)	9 lava-flow groups (each group contains multiple flows, erupted over a short time)	Dates from 600-foot interval of subsurface lavas give recurrence estimate consistent with surficial geology of the area	45,000 yrs ($2.2x10^{-5}$ /yr)
Borehole RWMC 77-1 (southwestern INEEL)	Kuntz, 1978; Anderson & Lewis, 1989	100,000 - 565,000 yrs (K-Ar and TL dating; palemagnetic data)	11 lava-flow groups (each group contains multiple flows, erupted over a short time)	Dates from 600-foot interval of subsurface lava give longer recurrence interval than nearby Arco & Axial zones, reflecting flow-group (sub-surface) vs. vent-counting (surface geology) approaches	45,000 yrs ($2.2x10^{-5}$ /yr)

Source: Woodward-Clyde 1996.

The Axial Volcanic Zone (16,000 year recurrence) provides a bounding value of eruption probability for the INEEL volcanic zones because it has erupted most frequently, and because the southern parts of the Arco-and Lava Ridge-Hell's Half Acre VRZ merge with it (Table E-2.1.2-1). Specific sites of future eruptions cannot be forecast, however, as estimate of the probability of future lava flows inundating a random site within a VRZ can be constructed. Hackett and Smith (1994) estimated the general probability for lava flow inundation within each of the INEEL volcanic zones. They assumed that every eruption would produce a lava flow of average dimensions, and terrain factors were ignored. The average INEEL lava flow of the past 40,000 years is 5 miles long and covers 18 square miles. The annual probability of a 18 mi^2 lava flow inundating a random site within the Axial Volcanic Zone (386 mi^2 area) is $2.9x10^{-6}$ per year. The Arco VRZ has erupted about as frequently as the Axial Volcanic Zone, and it covers about 115 square miles. The annual probability for the Arco Volcanic Zone is approximately $9.3x10^{-6}$ per year. For a random site within the Lava Ridge-Hell's Half Acre VRZ (193 mi^2 area), the probability is about $2.4x10^{-6}$ per year.

It is important to emphasize that these probabilities are not equivalent to site-specific risk assessments, because only source terms were considered within the context of several simplifying assumptions. Site-specific assessments must incorporate other factors including distance from the source zone(s), the influence of local terrain upon lava paths, the consequences of volcanic effects, and the potential success of mitigation measures (e.g., construction of barriers or removal of property).

Other hazardous phenomena (i.e., tephra fall, volcanic-gas emissions, and magma-induced ground deformation) are expected to accompany virtually all basaltic volcanic eruptions, however, the affected areas are assessed to be smaller than the areas inundated by lava flows (Hackett & Smith 1994).

E-2.2 Water Resources

The evaluation of potential consequences to water resources at the INEEL, particularly the RWMC, focused on flooding potential, water quality and water use. The following sections discuss the methods and references used to determine impacts resulting from the implementation of the waste management activities for the proposed alternatives.

DOE conducted an extensive review of the INEEL's potential environmental consequences to water resources for the alternatives (DOE INEL EIS Sections 4.8, 5.8 and Appendix F.2.2). In lieu of duplication of that discussion in this environmental impact statement (EIS), the applicable sections of the DOE INEL EIS Volume 2 (Appendix F.2.2) for surface and subsurface water, and water use are referenced, and new information and data applicable to water resources are provided.

E-2.2.1 Surface Water

Surface water studies and data were reviewed during a literature search performed for this EIS. This section presents the methodology used for the analyses of potential impacts of the AMWTP alternatives to natural and artificial (manmade) surface waters on and in the vicinity of the RWMC. These methods were used to determine existing surface water quality and flood potential.

The U.S. Geological Survey (USGS) has been compiling surface water quality data for many years at the INEEL. Many potential sources of surface water contamination are identified also in the Federal Facility Consent Order. All potential contamination sources were evaluated, including facility-specific activities, material inventory, past spills and leaks, nonpoint source water discharge, and existing storm water monitoring data (DOE INEL EIS, Appendix F.2.2.1.1).

Under the Clean Water Act, two National Pollutant Discharge Elimination System (NPDES) General Permits for Storm Water Discharges were issued for the INEEL; one for industrial activities and one for construction activities. The permit requirements for both of these activities specify the development of a Site-Wide Storm Water Pollution Prevention Plan. Any facility at the INEEL having the potential to discharge storm water to the Big Lost River System associated with industrial or construction activities is subject to the monitoring and reporting requirements of the INEEL.

Water samples are collected during each quarter when sufficient rain falls or snow melts to produce enough runoff from the Transuranic Storage Area (TSA) asphalt pads and in the Subsurface Disposal Area (SDA) gate ditch. One sample is collected from the outfall that drains off of the TSA asphalt pads. In addition, a sample is taken at the point of discharge from the SDA near the sump pump. A control sample is collected to determine background concentrations of the radionuclides of interest at a location unaffected by facility operations upgradient of the SDA (LMITCO 1996). Results of the sampling are discussed in Section 4.8, Water Resources.

In addition, several USGS and INEEL studies have been conducted concerning flood potential at the INEEL. The USGS estimated peak flow and flow volume from the Big Lost River for a 100-year flood event. The estimated peak flow was 7,260 cubic feet per second. The estimated volume of flow for a 60-day period from a flood event likely to occur once in 100 years (100-year flood event) was 390,000 acre-feet for the entire INEEL (DOE-ID 1997c) (Kjelstrom and Berenbrock 1996). Acre-feet is the unit of measure in which one foot of water would cover one acre.

Dames and Moore (1993) conducted a flood design evaluation for the RWMC. The scope of work included hydrologic analyses including the development of 100-, 500-, 1,000-, and 10,000-year storm event, 1/2 probable maximum flood, and probable maximum flood hydrographs for subbasins contributing surface runoff to the Main Channel Flow System and East Channel Flow System at the RWMC. The work also included preparation of 100-year flood and probable maximum flood inundation map, development of alternative 100-, 500-, and 1,000-year rain-on-snow scenarios, and computation of revised flood elevations, along with surface runoff hydrographs for two specific cases. The utilized methodology divided the RWMC watershed basin into 21 separate drainage catchments (subbasins) for purposes of hydrologic analysis. The analysis was based on the probable maximum precipitation for each of the storm events analyzed. Subbasins were determined by delineating natural watershed boundaries for each catchment that is a tributary to the RWMC. Estimation of precipitation losses, times of concentration, and lag times were defined using a minimum of four different methods, respectively. These methods were analyzed through the U.S. Army Corps of Engineers flood hydrograph package modeling programs, Hydrologic Engineering Center (HEC)-1 for peak discharges and HEC-2 for water surface profiles, for the Main and East Channel Flow Systems to Big Lost River (Dames and Moore 1993). Based on the current drainage engineered structures (culverts and ditches), the study indicates that no flooding would occur for the 100-, 500-, 1,000- and 10,000-year storm event for the RWMC, specifically within the SDA. For the 1/2 probable maximum flood and probable maximum flood, overtopping of the culvert on Adams Boulevard would occur for the box culvert. The 100-year flood inundation map is presented in the report (Dames and Moore 1993).

In addition to the Dames and Moore report, the USGS plans to determine the extent of the 100-year floodplain for the Big Lost River and Birch Creek at the INEEL. A simulated 100-year peak flow, using a computer model, will be routed downstream to spreading areas and playas on the INEEL (DOE-ID

1997c). This modeling effort methodology will be similar to the study conducted by Dames and Moore in 1993 (Dames and Moore 1993).

E-2.2.2 Subsurface Water

The Snake River Plain Aquifer arcs approximately 220 miles through eastern Idaho's subsurface and varies in width from 50 to 70 miles (Becker et al. 1996). Total area of the Snake River Plain Aquifer is estimated at 9,600 square miles. Depth to groundwater at the INEEL ranges from approximately 200 feet below land surface in the north to over 900 feet in the south (Becker et al. 1996). The Snake River Plain Aquifer has been estimated to hold 2.5×10^{12} cubic meters of water, which is approximately equivalent to the amount of water contained in Lake Erie, or enough water to cover the entire State of Idaho to a depth of 4 feet (Becker et al. 1996). Water is pumped from the aquifer primarily for human consumption and irrigation. The INEEL's use of the aquifer is minor (Becker et al. 1996).

Groundwater parameters reviewed for this EIS were aquifer permeability, recharge and discharge areas, groundwater flow, and groundwater quality and use.

Improvement in management practices since 1952 at the RWMC have resulted in differences in soil covers, thickness, land contours, vegetation types, and proximity of buried waste to roads and ditches. Each of these factors influences soil moisture dynamics in the protective soil caps. Since 1988, the Environmental Science and Research Foundation has measured soil moisture on eight study sites within the RWMC, mostly during the late winter, early summer, and fall. Throughout that period, precipitation during the non-growing season ranged from 46.6 to 135.5 percent of normal (DOE-ID 1997c). Soil moisture recharge was generally less than 16 inches deep for all areas and years except for 1989, 1993 and 1995. During those years maximum infiltration was recorded at depths of up to 4.5 feet (DOE-ID 1997c).

Infiltration rate studies have been conducted at the RWMC and ranged from 0.14 inches per year in undisturbed sediments to 6.9 feet per day inside the SDA (i.e., disturbed sediments) within the RWMC (Becker et al. 1996). The basalt takes from 0.016 feet per day under normal infiltration conditions (i.e., undisturbed basalt under natural flow conditions) to 16.9 feet per day through fractured basalt during the aquifer pumping and infiltration test (i.e., pumping from a well) near the RWMC (Becker et al. 1996).

The Snake River Plain Aquifer is primarily recharged by infiltration from rain and snowfall that occurs within the drainage basin surrounding the Eastern Snake River Plain and from deep percolation of irrigation water and stream flow from rivers that lose water along their flowpaths. All rivers contribute to recharging the Snake River Plain Aquifer (Becker et al. 1996). If streamflow exists on the INEEL, it is lost to the ground and eventually recharges the Snake River Plain Aquifier (Becker et al. 1996).

Aquifer permeability is controlled by the distribution of highly fractured basalt flow tops, interflow zones, lava tubes, fractures, vesicles, and intergranular pore spaces. The variety and degree of interconnected water-bearing zones complicates the direction of groundwater movement locally throughout the aquifer (Becker et al. 1996). The permeability of the aquifer varies considerably over short distances, but generally, a series of basalt flows will include several excellent water-bearing zones. Estimates of flow velocities within the Snake River Plain Aquifer range between 5 and 20 feet per day. Transmissivity values range from $1.1 \text{ X } 10^{0}$ to 1.2×10^{7} square feet per day (Becker et al. 1996). Depth to groundwater near the RWMC is approximately 590 ft (Becker et al. 1996).

Discharge areas occur at springs and from pumping wells for water consumption. Major springs and see pages that flow from the aquifer on a regional scale are located near the American Falls Reservoir (southwest of Pocatello), the Thousand Springs area between Millner Dam and King Hill (near Twin Falls), and between Lorenzo and Lewisville, along the Snake River (DOE INEL EIS, Section 4.8.2.1).

Groundwater chemistry data were obtained by water sampling and chemical analysis. Sampled monitoring wells are purged until field parameters (pH, temperature, and specific conductivity) stabilize. This ensures that the sampled water is formation water and not residual water that has been chemically altered in the well. The USGS has been routinely monitoring wells at the INEEL since 1949 and uses these methods of sampling. Analytical techniques used to determine concentrations of solutes include liquid scintillation and alpha, beta, and gamma testing for radionuclides; atomic adsorption for metals and anions; and gas chromatography/mass spectrometry for volatile organic compounds. Recently, studies have used inductively coupled plasma-mass spectrometry for chemical analysis of cations, which offers lower detection limits and an expanded analyte list (DOE-ID 1997c). In 1996, the USGS routine groundwater surveillance program included collection of 374 samples for radionuclides and inorganic constituents including trace elements and 66 purgeable organic compounds on the INEEL.

Fate and transport modeling for the INEEL has been conducted previously and is discussed thoroughly in the DOE INEL EIS (Sections 5.8.1, 5.8.2.2, and Appendix F.2.2.2.3). Recent modeling activities include the fate and transport of volatile organic compounds for the SDA within the RWMC. The computer code used was PORFLOW™ and the analysis was conducted by Lockheed Idaho Technologies Company, Buried Waste and Landfill Department (Becker et al. 1996). This numerical simulation was conducted after installment of the vapor vacuum extraction wells. The wells were installed as part of a Record of Decision (ROD) between DOE, U.S. Environmental Protection Agency (EPA) and the State of Idaho to use the vapor vacuum extraction with treatment. Future modeling of the SDA for the proposed remedial investigation/feasibility study of Operable Unit 7-13/14 is planned for the future (Becker et al. 1996).

E-3 AIR RESOURCES

The characterization of air resources and assessment of impacts of alternative courses of action required (1) the performance of air dispersion modeling, and (2) the evaluation of results in terms of regulatory criteria developed to protect public health and welfare. Section E-3 presents background information related to these topics. The information presented herein supports the summary results presented in Sections 4.7 and 5.7 (Air Resources) and Sections 4.3 and 5.3 (Visual and Aesthetic Resources) of this EIS, which respectively describe the affected environment and consequences of alternatives on air quality.

The air resource assessments performed in support of this EIS utilized independent analyses performed by specialists from contractor organizations, as well as tiering from the DOE INEL EIS. Documents which are considered key references, their contents, and the manner in which they were used in the air resources assessments are summarized as follows:

- Application for a State of Idaho Permit to Construct (BNFL 1998c) and National Emission Standard for Hazardous Air Pollutants (NESHAP) (BNFL 1998a) analysis for radiological impacts. These documents provide data on facility location, design and projected emission rates.

- Material and energy balance calculations which were prepared to support permitting of the proposed AMWTP (BNFL 1998b). This document is also cited in the above-mentioned permit applications in support of emission calculations for criteria and selected toxic air pollutants.

- INEEL radiological NESHAP Reports for the calendar years 1995 and 1996 (DOE-ID 1996d, 1997b) were used to establish the existing radiological conditions in terms of airborne radionuclide emissions and highest dose to an offsite receptor.

- INEEL air emissions inventory for the years 1995 and 1996 (DOE-ID 1996b, 1997a) were used to update the criteria pollutant emission rates from existing INEEL facilities. These were compared with the emission rates which were used in the DOE INEL EIS to ensure that the current rates are within the bounds of those used in the DOE INEL EIS as a basis for characterizing existing conditions through atmospheric dispersion modeling.

Section E-3 attempts to integrate the descriptions of methods, assumptions, and other key information from the analyses cited above into a single source. The remainder of this section is organized as follows:

- Section E-3.1 presents background environmental information on the INEEL.

- Section E-3.2 contains a description of air quality standards and regulations, and a discussion of how they apply to sources at the INEEL. This section also details the controls incorporated into the proposed AMWTP to minimize air quality impacts and ensure regulatory compliance.

- Section E-3.3 provides supplemental information on the methods and assumptions used to estimate emissions and assess baseline conditions and impacts of releases of radiological and nonradiological pollutants.

E-3.1 The Idaho National Engineering and Environmental Laboratory Environment

This section describes background levels of radiation, airborne radioactivity, and nonradiological air quality in the environs of the INEEL.

E-3.1.1 Radiation and Airborne Radioactivity

The population of the Eastern Snake River Plain is exposed to environmental radiation from both natural and other sources of human origin. The predominant source of radiation in the region is the natural radiation background, a term that refers to natural sources of radiation to which humans are continuously exposed. Background radiation includes sources such as cosmic rays; radioactivity naturally present in soil, rocks, and the human body; and airborne radionuclides of natural origin (such as radon). The dose from background radiation results from sources that can be either external (outside the body) or internal (within the body). External sources consist primarily of cosmic rays and radioactivity within soil and rocks. Internal sources include radioactivity naturally present within the human body and airborne radioactivity of natural origin that can deposit in the lungs when inhaled. The natural background dose for residents of the Eastern Snake River Plain is estimated at about 360 millirem per year, with more than half (about 200 millirem per year) caused by the inhalation of radioactive particles formed by the decay of radon (DOE-ID 1997b).

In addition to natural background sources, residents of the Eastern Snake River Plain receive exposure from other sources of human origin, including medical X-rays, nuclear medicine diagnostic procedures, consumer products (such as televisions, smoke detectors, or self-luminous products), and radioactivity remaining in the environment as a result of worldwide atmospheric testing of nuclear weapons. Collectively, these result in an annual dose of about 68 millirem to the average U.S. population member, with most of this dose (about 54 millirem per year) resulting from the medical use of radiation (NCRP 1987). This dose does not include the contribution from radioactivity in tobacco products, which results in a substantial radiation dose (several rem per year) to the lungs of smokers. Additional information related to radiological conditions (including monitoring results and airborne radioactivity associated with existing INEEL facilities) is presented in the site environmental report (DOE-ID 1997c).

E-3.1.2 Background Nonradiological Air Quality

As used here, the term background air quality refers to the levels of nonradiological air pollutants in ambient air that are not attributable to INEEL activities. Regional ambient air monitoring data is sparse, however, it is recognized that air quality in the area is good. Some data have been collected by the National Park Service (NPS) at Craters of the Moon Wilderness Area. That monitoring program has shown no exceedances of the primary ozone standard, low levels of sulfur dioxide, although there was one exceedance for the 24-hour maximum standard in 1985, and total suspended particulate matter within the applicable standards.[1] The NPS has concluded that available data do not currently indicate a significant threat to Craters of the Moon Wilderness Area from gaseous pollutants (DOI 1994, Section IV.B.3.a.iii). More

[1] Standards for total suspended particulates have since been replaced with standards for respirable-sized particulate matter, usually referred to as PM-10.

recently the NPS has upgraded this program to include aerosols and fine particulates. The NPS also monitors parameters related to the estimation of background visual range, which they have estimated to be 144 miles annual average (Notar 1998a).

E-3.2 Air Quality and Environmental Protection Standards and Regulations

Air quality regulations have been established by Federal and State agencies to protect the public from potential harmful effects of air pollution. The Federal *Clean Air Act* (CAA) establishes the framework to protect the nation's air resources and public health and welfare.

EPA and the State of Idaho are jointly responsible for establishing and implementing programs that meet the requirements of the CAA. These regulations are based on an overall strategy that incorporates the following principal elements:

- Designation of acceptable levels of pollution in ambient air to protect public health and welfare;
- Implementation of a permitting program to regulate (control) emissions from stationary (nonvehicular) sources of air pollution; and
- Issuance of prohibitory rules, such as rules prohibiting open burning.

Facilities planned or currently operating at the INEEL are subject to air quality regulations and standards established under the CAA and by the Idaho Department of Health and Welfare (IDHW), Division of Environmental Quality, and to internal policies and requirements developed by DOE for the protection of the environment and health. At the INEEL, programs have been developed and implemented to ensure compliance with air quality regulations by (1) identifying sources of air pollutants and obtaining necessary State and Federal permits, (2) providing adequate control of emission of air pollutants, (3) monitoring emissions sources and ambient levels of air pollutants to ensure compliance with air quality standards, (4) operating within permit conditions, and (5) obeying prohibitory rules. Air quality standards and programs applicable to INEEL operations are summarized in Figure E-3-1 and are described in further detail below. This section also provides information on project design features to mitigate air quality impacts and operate within the bounds of regulatory requirements.

Clean Air Act

Federal Program

National Ambient Air Quality Standards (NAAQSs)

- Set limits on ambient air concentrations of sulfur dioxide, nitrogen dioxide, respirable particulate matter, carbon monoxide, lead, and ozone (criteria pollutants).
- Primary standards for protection of public health; secondary standards for protection of public welfare.

Prevention of Significant Deterioration (PSD)

- Limits deterioration of air quality and visibility in areas that are better than the NAAQSs.
- Requires Best Available Control Technology on major sources in attainment areas.

New Source Performance Standards

- Regulate emissions from specific types of industrial facilities (for example, fossil fuel-fired steam generators and incinerators).

National Emission Standards for Hazardous Air Pollutants (NESHAP)

- Control airborne emissions of specific substances harmful to human health.
- Specific provisions regulate hazardous air pollutants and limit radionuclide dose to a member of the public to 10 millirem/year.
- Proposed regulation will control emission of hazardous air pollutants from combustion of hazardous waste.

Clean Air Act (CAA) Amendments of 1990

- Sweeping changes to the CAA, primarily to address acid rain, nonattainment of NAAQSs, operating permits, hazardous air pollutants, potential catastrophic releases of acutely hazardous materials, and stratospheric ozone depletion.
- Specific rules and policies not yet fully developed and implemented in all areas (for example, hazardous air pollutants).

State of Idaho Administration Program

Rules for the Control of Air Pollution in Idaho
Current Regulations of the State of Idaho Department of Health and Welfare (IDHW 1997) include:

- **Idaho Ambient Air Quality Standards -** Similar to NAAQSs but also include standards for total fluorides.
- **New Source Program -** Permit to construct is required for essentially any construction or modification of a facility that emits an air pollutant; Major facilities require PSD analysis and permit to construct.
- **Carcinogenic and Noncarcinogenic Toxic Air Pollutant Increments -** Defines acceptable ambient concentrations for many specific toxic air pollutants associated with sources constructed or modified after May 1, 1994; Requires demonstration of preconstruction compliance with toxic air pollutant increments.
- **Operating Permits -** Required for nonexempt sources of air pollutants; Define operating conditions and emissions limitations, as well as monitoring and reporting requirements.

Rules and Standards for Hazardous Waste

- Includes standards for hazardous waste treatment facilities, including limits on emissions.
- Consistent with federal standards.

DOE Compliance Program

Policy to comply with applicable regulations and maintain emissions at levels as low as reasonably achievable.
Policy implemented through DOE orders.

- DOE (Headquarters) orders apply to all DOE and DOE-contractor operations.
- DOE-Idaho Operations Office (DOE-ID) supplemental directives provide direction and guidance specific to the INEEL.

The most relevant DOE orders and their DOE-ID supplemental directives are:

- **DOE Order 5400.1** establishes general environmental protection program requirements and assigns responsibilities for ensuring compliance with applicable laws, regulations, and DOE policy.
- **DOE Order 5400.5** provides guidelines and requirements for radiation protection of the public.
- **DOE Order 5480.1B** establishes the Environment, Safety, and Health (ES&H) Program for DOE operations (implemented via DOE-ID Supplemental Directive 5480.1).
- **DOE Order 5480.4** prescribes the application of mandatory ES&H standards that shall be used by all DOE and DOE-contractor operations (implemented via DOE-ID Supplemental Directive 5480.4).
- **DOE Order 5480.19** provides guidelines and requirements for plans and procedures in conducting operations at DOE facilities (implemented via DOE-ID Supplemental Directive 5480.19).

Figure E-3-1. Overview of Federal, State, and DOE programs for air quality management.

E-3.2.1 Ambient Air Quality Standards

The CAA establishes National Ambient Air Quality Standards (NAAQS) to protect public health and welfare. Primary standards define the ambient concentration of an air pollutant below which no adverse impact to human health is expected. A second category of standards (called secondary standards) has been established to prevent adverse impacts on public welfare, including aesthetics, property, and vegetation. Certain standards apply to long-term (annual average) conditions; others are short-term, applying to conditions that persist for periods ranging from one hour to three months, depending on the toxic properties of the pollutant in question. Ambient standards have been developed for only a few specific contaminants, namely respirable particulate matter (particles not larger than 10 micrometers in diameter, which tend to remain in the lung when inhaled), sulfur dioxide, nitrogen dioxide, carbon monoxide, lead, and ozone. In addition, the State of Idaho has also established an additional State ambient air quality standard for fluorides in vegetation.[1] Standards for these "criteria air pollutants" are used in Section 5.7, Air Resources, in the regulatory compliance evaluations of projected AMWTP emissions (see Table 5.7-4).

The EPA and the State of Idaho have monitored ambient air quality in an attempt to define areas as either attainment (that is, the standards are not exceeded), or nonattainment of the ambient air quality standard, although many areas are unclassified due to a lack of regional monitoring data. The attainment status is specific to each pollutant and averaging time. Designation as either attainment or nonattainment not only indicates the quality of the air resource but also dictates the elements that must be included in local air quality regulatory control programs. Unclassified areas are generally treated as being in attainment. The elements required in nonattainment areas are more comprehensive (or stricter) than in attainment areas. The region that encompasses the environs of the INEEL has been classified as attainment or unclassified for all NAAQS, meaning that air pollution levels are considered healthful. The nearest nonattainment area lies some 50 miles south of the INEEL in Power and Bannock Counties. This area has been designated as nonattainment for the standards related to respirable particulate matter.

E-3.2.2 Prevention of Deterioration

The CAA contains requirements to prevent the deterioration of air quality in areas designated as attainment of the ambient air quality standards. These requirements are contained in the Prevention of Significant Deterioration (PSD) amendments and are administered through a program that limits the increase in specific air pollutants above the levels that existed in what has been termed a baseline (or starting) year. The amendments specify maximum allowable ambient pollutant concentration increases, or increments. Increment limits for pollutant level increases are specified for the nation as a whole (designated as Class II areas), and more stringent increment limits (as well as ceilings) are prescribed for designated national resources, such as national forests, parks, and monuments (designated as Class I areas). In Southeastern Idaho, the Craters of the Moon Wilderness Area is the only Class I area. Increment values applicable to the INEEL are presented in Section 4.7.

The IDHW, Division of Environmental Quality, administers the PSD Program. Proposed new sources of emissions at the INEEL and modifications are evaluated to determine the expected level of emissions of all pollutants. The INEEL is considered a major source, since facility-wide emissions of some air contaminants exceed 250 tons per year. As such, a PSD analysis must be performed whenever any

[1] This standard however is less restrictive than more recently promulgated for toxic air pollutants.

modification would result in a significant net increase of any air pollutant. Levels of significance range from very small quantities (less than one pound) to over 100 tons per year, depending on the toxic nature of the substance. For radionuclides, significance levels range from any increase in emissions to that which would result in an offsite dose of 0.1 millirem per year or greater, depending on total facility emissions. If an INEEL facility requires a PSD permit, it must be demonstrated that the source:

- Will be constructed using best available control technology (a level of control which is technologically feasible and considered cost-effective) to reduce air emissions;
- Will operate in compliance with all prohibitory rules;
- Will not cause a detriment to ambient air quality at the nearby Craters of the Moon Wilderness Area, a PSD Class I area; and
- Will not result in an exceedance of an ambient air quality standard.

The evaluation also includes an assessment of potential growth and associated impacts to air quality-related values—visibility, vegetation, and soils. Generally, all PSD projects must go through a public comment period with an opportunity for public review. The INEEL has been granted more than 20 PSD permits by the Division of Environmental Quality.

E-3.2.3 National Emission Standards for Hazardous Air Pollutants

In addition to ambient air quality standards and PSD requirements, the CAA designates requirements for sources that emit substances designated as hazardous air pollutants. These requirements are specified in a program termed NESHAP. This program was substantially amended in 1990 and has yet to be fully implemented. However, one section of the NESHAP program that currently applies to INEEL operations is contained in Title 40 of the Code of Federal Regulations (CFR) Part 61, Subpart H, *National Emissions Standards for Radionuclides from Department of Energy Facilities*. This regulation establishes a limit to the dose that may be received by a member of the public due to operations at the INEEL. The annual dose limit (10 millirem) applies to the maximally exposed offsite individual and is designed to be protective of human health with an adequate margin of safety. The regulation also establishes requirements for monitoring emissions from facility operations and analysis and reporting of dose.

The INEEL complies with the requirements of the NESHAP through programs to monitor radionuclide emissions, evaluate dose to nearby residences, and report doses annually to the EPA. Proposed new sources of emissions at the INEEL and modifications are evaluated to identify the expected contribution to dose to nearby residents. If specified levels (fractions of the acceptable dose for combined site operations) are exceeded, a NESHAP permit application is prepared for submittal to the EPA. New sources are also evaluated to determine emissions monitoring requirements. The INEEL currently holds more than 25 NESHAP permits granted by the EPA.

In addition to radionuclides, emissions standards have been established under the NESHAP Program for several nonradiological hazardous air pollutants, including benzene, asbestos, and others. The INEEL complies with the requirements for evaluation, control, and permitting of nonradiological hazardous air pollutants through programs that are also administered by the EPA. In accordance with Title III of the 1990 Amendments to the CAA, maximum achievable control technology (MACT) will be specified by the

EPA for various source categories. The MACT will require a level of control at least as stringent as the best performing (i.e., best controlled) sources within each source category. Sources will be required to implement programs or controls to comply with the MACT by the scheduled implementation date. If the residual risk is above specified acceptable limits, additional controls will be required. Several maximum achievable control technology standards have been promulgated or proposed. Proposed MACT emission standards and work practice requirements associated with combustion of hazardous waste are expected be issued in final form prior to the operation of the proposed AMWTP. The proposed AMWTP, has, therefore, been designed to meet or exceed the proposed emissions standards, as well as limit residual risk to levels which will protect the public and occupational workers. Table E-3-1 contains proposed emission standards (expressed as stack concentrations) and a comparison to maximum projected AMWTP stack concentrations. The concentration estimated for mercury is higher than the MACT standard; however, this is due to the very conservative assumption that the waste to be incinerated contains 1 percent mercury. Preliminary waste characterization indicates the actual mercury content to be much less than 1 percent. Feed rate limits or other restrictions would be used to ensure that actual stack emissions comply with the MACT standard. The MACT rule will also require a vigilant program of monitoring, recordkeeping, and periodic reporting to EPA and/or the State of Idaho to document and certify operational compliance.

It is also expected that additional INEEL air emissions sources will be assigned MACT requirements as standards are promulgated for additional source categories, including (but not limited to) waste treatment, storage and disposal facilities, research and development activities, industrial boilers, process heaters, stationary internal combustion engines, other hazardous waste incinerators, and site remediation activities.

E-3.2.4 State of Idaho Permit Programs

The Idaho Air Pollution Control Program, administered by the Division of Environmental Quality, requires that permits be obtained for potential sources of air pollutants. Unless the source is specifically exempt from permitting requirements, Permits to Construct and Operate must be obtained before a source can be constructed or operated. The permits specify source requirements, such as monitoring, reporting and recordkeeping, or limitations on operating conditions, such as emission limits. The list of equipment or operations which are exempt from permit requirements is very specific and limited; most new INEEL sources and modifications to existing sources are subject to permit requirements.

In addition to individual source permits, the INEEL is also required to obtain a Sitewide “Title V” Operating Permit, as stipulated under the 1990 CAA Amendments, which must be renewed periodically. The INEEL submitted an application for a Title V Operating Permit in July 1995. Permits are typically issued with specific emissions limits and conditions for operation. This formal permitting process allows the State to determine that emissions will be adequately controlled, the source will comply with all emission standards and regulations, and public health and safety will be adequately protected. Generally, Operating Permit reviews must go through a public review period with an opportunity for public comment. The MACT program (Title III of the 1990 CAA Amendments which is discussed above) will be administered under the Title V program and also allow for public review and comment.

Table E-3-1. Proposed MACT standards for combustion of hazardous waste and maximum estimated AMWTP stack concentrations.

Hazardous Air Pollutant or Surrogate	Proposed Standard[a]	Maximum Projected Stack Concentration[b]
Dioxins and Furans (nanograms per dry standard cubic meter, as 2,3,7,8-TCDD equivalent)	0.20	-[c]
Mercury (micrograms per dry standard cubic meter)	40	83[d]
Particulate Matter[e] (micrograms per dry standard cubic meter)	0.015	0.00014
Hydrogen Chloride and Chlorine (parts per million by volume as hydrogen chloride equivalents)	75	0.37
Semi-Volatile Metals (total lead and cadmium, micrograms per dry standard cubic meter)	100	0.00028
Low-Volatile Metals (total antimony, arsenic, beryllium and chromium, micrograms per dry standard cubic meter)	55	0.00042
Carbon Monoxide[f] (parts per million by volume)	100	0.95
Hydrocarbons[f] (parts per million by volume, as propane)	10	0.2

a. All MACT concentrations are based on dry, standard conditions corrected to 7 percent oxygen.

b. Concentration in main stack exhaust based on maximum hourly emission rates listed in Table E-3-3 and stack flow rate of 130,000 actual CFM and 14 percent oxygen (corrected to 7 percent for comparison to standard). Applies only to thermal treatment alternatives (Proposed Action or Treatment and Storage).

c. Dioxin and furans emission rates are not specifically estimated, but are assumed to be equal to the MACT limit; trial burns would be required to establish that the MACT-prescribed concentration will not be exceeded.

d. The mercury emission rate listed in Table E-3-3 is based on the conservative assumption that the waste feed contains 1 percent mercury. Preliminary waste characterization indicates the actual mercury content to be much less than 1 percent. Feed limits or other restrictions could be imposed to reduce the stack concentration to below the MACT standard.

e. Particulate matter is specified as a surrogate for control of non-mercury metals.

f. Pollutants are specified as surrogate indicators of good combustion control.

E-3.2.5 State of Idaho Rules for Toxic Air Pollutants

The Idaho Division of Environmental Quality has promulgated rules and methodologies to estimate and control the potential human health impacts of toxic air pollutants (pollutants which by their nature are toxic to human or animal life or vegetation) from new or modified sources.[1] These rules are contained in Title 1, Chapter 1, Sections 585 and 586 of the Rules for the Control of Air Pollution in Idaho (IDHW 1997) and are implemented through the air quality permit program described above. Emission levels of significance have been established for about 700 toxic air pollutants, based on the known or suspected toxicity of these substances. Expected (uncontrolled) emissions above administrative screening levels must be evaluated using standard air dispersion modeling techniques and risk assessment methodologies to assess potential impacts. The State has defined acceptable ambient concentration levels for many toxic air pollutants, including both carcinogenic and noncarcinogenic contaminants. These levels are increments over existing levels and apply only to sources that became operational after May 1, 1994.

For contaminants known or suspected to cause cancer in humans, this level has been defined as the acceptable ambient concentration for a carcinogen (AACC). The acceptable ambient concentration for a carcinogen is based on risk and corresponds to that concentration at which the probability of contracting cancer is one in a million, assuming continuous exposure over a 70-year lifetime.[2] The AACC differs for each carcinogenic substance due to its carcinogenic potency, as defined by the EPA. The State will grant a permit if the calculated incremental risk due to project emissions does not exceed the AACC (that is, does not result in an individual excess cancer risk greater than one in a million). If this level is expected to be exceeded, a permit may still be granted if (a) the calculated risk does not exceed ten in a million and (b) toxic reasonably achievable control technology (which is similar to best available control technology, or BACT) is employed to limit emissions of carcinogenic substances. A facility will not be granted a permit unless it can be shown that the emissions will comply with all applicable toxic air pollutant increments for carcinogenic (cancer-causing) and noncarcinogenic substances (IDHW 1997). As part of the permit evaluation process, requirements related to toxic air pollution control equipment, facility modifications, and materials substitutions may be specified to limit ambient levels of toxic air pollutants.

Many air contaminants do not cause cancer but may contribute to other health impacts, such as respiratory or eye irritants, or impacts to the cardiovascular, reproductive, central nervous or other body systems. Levels of significance for noncarcinogenic substances are called acceptable ambient concentrations (AAC). The AAC is based on acceptable exposure limits for occupational workers and other reference sources of information for the contaminant in question. For an added margin of safety, the State generally sets the AAC at one-hundredth of the acceptable occupational exposure level. Permits are granted if incremental emissions from the new or modified source are expected to result in annual average concentrations below the AAC. However, if the AAC is expected to be exceeded, a permit may still be granted based on consideration of other factors, such as the toxicity of the substance and anticipated level of exposure.

E-3.2.6 Standards for Hazardous Waste and Toxic Substance Control

In addition to regulations designed specifically for air resource protection, projects which include handling or treatment of hazardous substances are required to comply with various Federal and State environmental regulatory programs which incorporate certain requirements on releases to air. Among the

[1] The method used to assess cancer health risk associated with air emissions form current INEEL facilities and proposed AMWTP alternatives is summarized in Appendix E-4, Health and Safety.

[2] This probability is often described as an “individual cancer risk.” Excess, in the sense used here, means above the normal cancer incidence rate, which is currently about one in three for the U.S. population. An individual excess cancer risk of one in a million or less is generally considered an acceptable level of risk.

most important of these are requirements for hazardous waste incineration are the standards for the destruction of organic hazardous constituents in solid wastes prescribed by EPA and IDAPA 16.01.05.008 (40 CFR 264 Subpart O). Polychlorinated biphenyls (PCB) incineration must achieve the minimum 99.9999 percent destruction and removal efficiency of the Toxic Substances Control Act (TSCA), while incineration of other difficult-to-destroy compounds, such as chlorobenzene and carbon tetrachloride, must achieve a minimum 99.99 percent destruction and removal efficiency. Resource Conservation and Recovery Act (RCRA) performance standards for hydrogen chloride emissions in IDAPA 16.01.05.008 require either 99 percent hydrogen chloride removal or less than 4 pounds per hour hydrogen chloride during the incineration of chlorinated wastes.

E-3.2.7 Department of Energy Orders and Guides

The DOE has developed and issued a series of orders and guides to ensure that all operations comply with applicable environmental, safety, and health regulations and DOE internal policies, including the concept of maintaining emissions and exposures to the public and workers at levels that are as low as reasonably achievable. The as-low-as-reasonably-achievable concept is employed in the design and operation of all facilities and applies to all types of air pollutants (for example, radionuclides, carcinogens, toxic and criteria air pollutants). Orders specifically designed for protection of environment, safety, and health are summarized in Section F-3.3.2 of the DOE INEL EIS.

E-3.2.8 Measures to Minimize Impacts

Specific features have been incorporated into the proposed AMWTP design, which, together with operational controls and practices, will reduce environmental impacts of releases of air contaminants. Many mitigation features are required by regulations related to hazardous waste treatment, storage and disposal facilities, and State and Federal Rules for the control of air pollution. Specific regulatory requirements will be incorporated into permit conditions related to proposed AMWTP construction and operation, and compliance with these requirements will be subject to regulatory oversight. Other mitigation features, while not specifically required by regulation, are necessary elements of the ALARA program to ensure protection of the public, workers and the environment.

Mitigation design features related to each of the processes which comprise the AMWTP alternatives (specifically, thermal and/or non-thermal treatment) are discussed below, including the separate air pollution containment and control systems which serve the pretreatment area, incinerator, vitrifier/melter, and evaporator.

E-3.2.8.1 Pretreatment Area (Zone 3 and Glovebox). Pre-treatment is an essential step in both the Proposed Action and Non-Thermal Treatment Alternatives. All uncontained waste will be located in Zone 3 areas—the interior of hot cells, process cells, glove boxes, or other containments for handling highly contaminated materials. A recirculatory self-cleaning reverse jet air filtration system will provide continuous air treatment and reduce dust loading in Zone 3 areas. Containment features will prevent the spread or release of contaminant materials both within the facility and to the environment. Air extracted from Zone 3 areas will be passed through three stages of high efficiency particulate air (HEPA) filtration before exiting through the facility stack. Each bank of HEPA filters includes a backup capacity. In some areas, carbon filtration is also provided downstream from the first-stage HEPA filters to capture organic emissions. The system is shown schematically in Figure E-3-2.

E-3.2.8.2 Incinerator Design Requirements and Control Features. The proposed AMWTP incinerator has been designed to operate within the specifications of current and proposed regulations for combustion of hazardous waste. In particular, the following design and operational features will mitigate the production and release of air pollutants (BNFL 1998c):

- Controlled feed streams to the incinerator including limits on hourly feed rate, and maximum chlorine, ash and regulated metals feed rates;
- Controlled combustion with temperature (1,800 – 2,200°F), pressure, gas velocity, residence time (nominal 2-second), waste feed rate and other combustion parameters continuously monitored and controlled as a means to achieve the minimum required destruction and removal efficiency for organic hazardous constituents;
- Independent air pollution control systems for the incinerator, vitrifier/melter and ancillary processes;
- Good Engineering Practice stack design to minimize concentrations of contaminants in the building cavity, and provide good dispersion of process effluents (MK 1997);
- Various controls and parameter monitoring and recording to ensure proper system operation and compliance with standards; and
- Trial burn, startup, and testing of incinerator operations which will occur for a period of several months with simulant chemicals and materials that are not regulated as hazardous wastes.

The incinerator system has been designed to function in compliance with current hazardous waste incinerator guidance and performance standards for the destruction of organic hazardous constituents in solid wastes of EPA and IDAPA 16.01.05.008 (40 CFR 264 Subpart O). Since a TSCA permit for PCB incineration will be obtained, the project has been designed to meet the minimum combustion efficiency of TSCA. Trial burns will be conducted to ensure that a 99.9999 percent PCB destruction and removal efficiency is maintained. The facility is also designed to achieve a 99.99 percent destruction and removal efficiency for difficult-to-destroy compounds, such as chlorobenzene and carbon tetrachloride, which will also be confirmed during trial burns. The facility includes a scrubbing system for hydrochloric acid removal which will be operated to comply with the RCRA hydrogen chloride performance standard in IDAPA 16.01.05.008 which requires either 99 percent hydrogen chloride removal or less than 4 pounds per hour hydrogen chloride during the incineration of chlorinated wastes to be demonstrated during the trial burns.

The incinerator and offgas control system has also been designed to function within the framework of the recently proposed emission limits of the hazardous waste combustion MACT rule of Title III, Section 112 of the CAA. The proposed MACT contains emission limitations, which will control emissions to a level at least as stringent as the best performing (i.e., best controlled) hazardous waste combustion system, are provided in Table E-3-1.

In addition, public health and safety will be reevaluated in the project permitting phase through the use of health risk assessments to be conducted in accordance with IDAPA 585 and 586. The health risk assessment will incorporate emissions data collected during trial burns and must demonstrate that the Idaho Administrative Procedures Act (IDAPA) increments designed for protection of the public from

Figure E-3-2. Schematic of Zone 3 and glovebox exhaust system (BNFL 1998b).

releases of toxic air pollutants are not exceeded. If necessary, additional controls will be placed on the project if required to meet these standards for public health and safety.

E-3.2.8.3 Incinerator Air Pollution Control System. The incinerator air pollution control system includes a combination of dry filtration and wet scrubbing systems, with quench air cooling, a high-temperature filter, saturation quencher, packed-bed absorber for acid gas and mercury removal, a candle demister, three-stage HEPA filtration, associated pumps and blowers, and an exhaust stack. The system is shown schematically in Figure E-3-3.

Flue gas from the secondary combustion chamber is first cooled by mixing with ambient air through dedicated air supply blowers. It is then directed into one of two parallel redundant high-temperature filter vessels. The hot filters are designed for more than 99 percent removal of particles greater than 0.5 microns in diameter and are cleaned in place using a jet-pulse blowback system. The gas exiting the high-temperature filtration units enters the quench tower where it is cooled and saturated with quench brine spray. The gas discharges directly to the packed-bed absorber below the packed-bed column.

Alkaline clean liquor solution absorbs the acidic gases to form salts. The scrubber system is capable of removing over 99 percent of the acid gas from the offgas and has been specially designed to remove mercury from the offgas and scrubber brine. The mercury is gravity drained and manually tapped from the bottom of the holding tank for amalgamation. Clean liquor solution falls from the packed-bed and collects in the sump. From there it is pumped to the scrubber liquor hydrocyclone where large solids are removed from the liquid. Underflow from the hydrocyclone is continuously recirculated to the packed-bed absorber. The rate of recirculation is controlled with addition of caustic to maintain a minimum pH, and process water or separator condensate added to adjust the concentration.

Flue gas from the scrubber tower enters the candle demister vessel and passes through the mist eliminator candles. The candles are continuously irrigated with a spray of fresh water to remove water soluble constituents from the fiber media. The saturated gas leaving the candle demister vessel is ducted to an in-line resistance reheater that raises the temperature above the saturation temperature prior to passing through three sets of HEPA filter banks. The first stage contains redundant parallel modules, consisting of two filters in series (65 percent and 90 percent roughing filters), and a glass-matrix nuclear-grade HEPA filter. The second stage contains redundant parallel modules each consisting of a 90 percent roughing filter and a nuclear-grade stainless steel or higher alloy nuclear-grade HEPA filter in series. The third stage will include a nuclear-grade HEPA filter. HEPA filters are certified capable of removing 99.97 percent of all particulate in the range of 0.1 to 0.3 microns in diameter (which is the most difficult size range for particulate removal), with increased efficiency for all other particle diameters

Following the second stage of HEPA filter modules, the flue gas passes to the exhaust blower where it is delivered to the stack. A variable damper on the suction side of the blowers allows control of the draft to maintain negative pressure within the incinerator system and to sustain the movement of the flue gas through the air pollution control system.

E-3.2.8.4 Vitrification Offgas Treatment System. The vitrification process includes a feed system, a melter, the glass form handling system and an air pollution control system. Each vitrification unit has two discharge chambers each protruding into separate gloveboxes. The inside of the vitrification unit and its separate glovebox is a single continuous containment area with a single common ventilation system maintained at negative pressure with respect to the surrounding process cells. The system is shown schematically in Figure E-3-4.

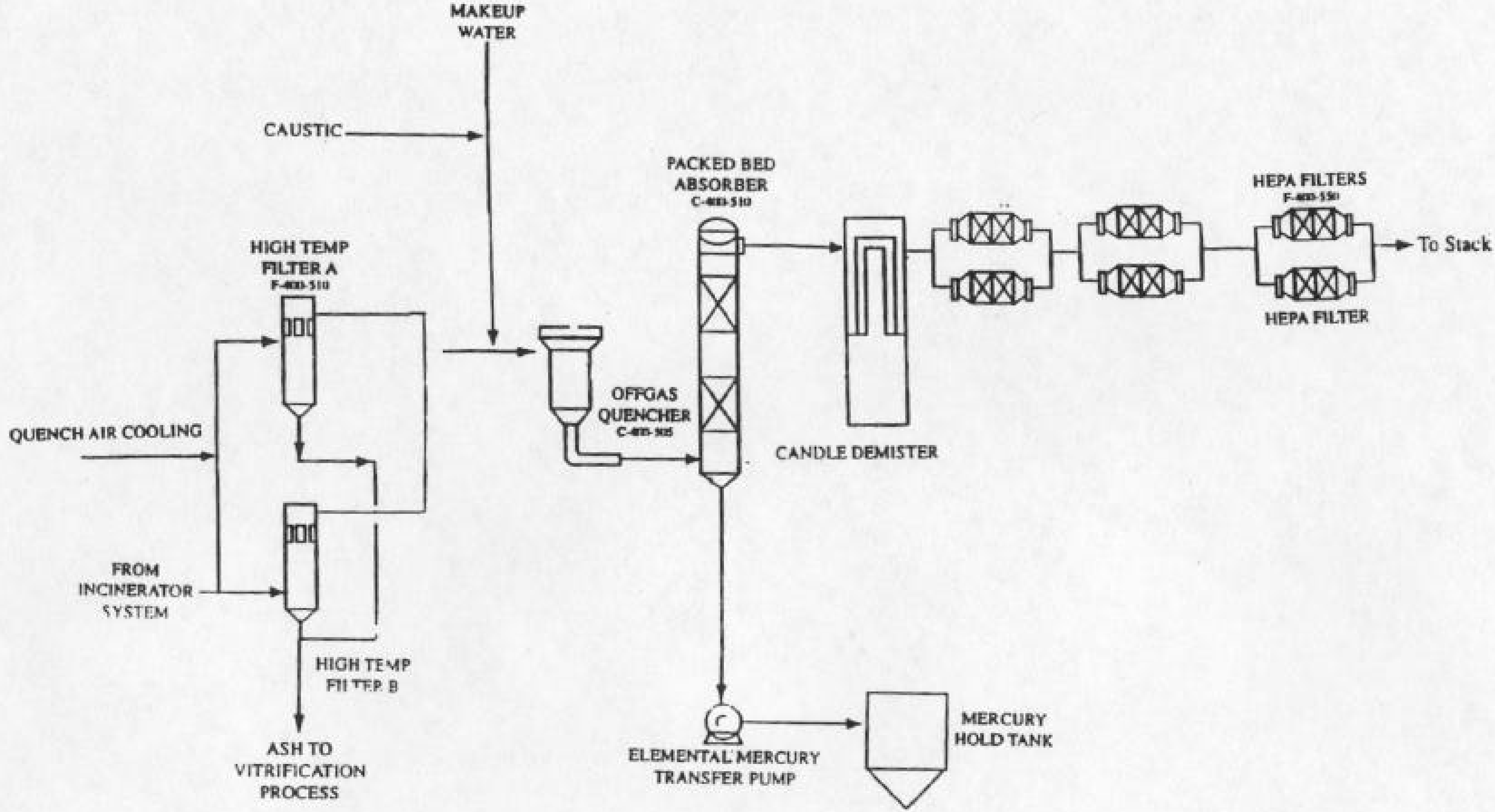

Figure E-3-3. Simplified schematic of the incinerator air pollution control system (BNFL 1998a).

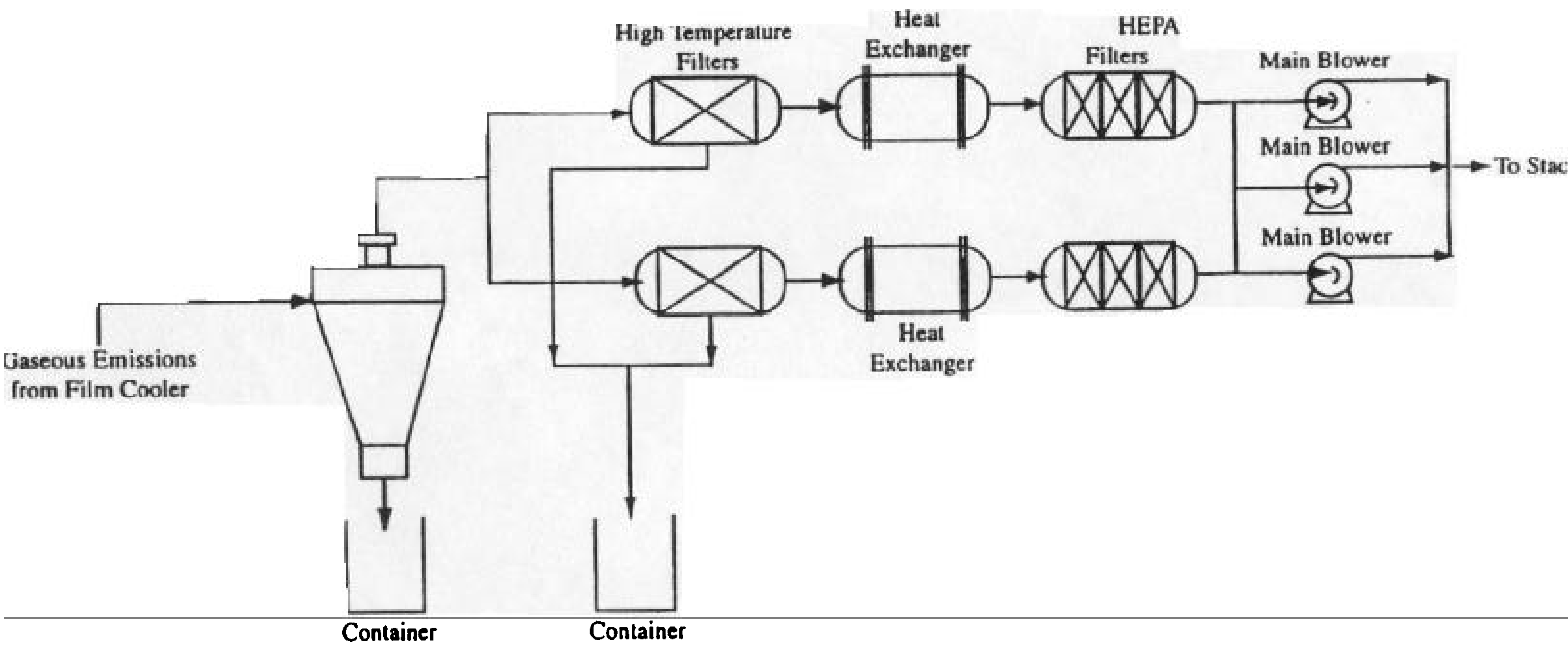

Figure E-3-4. Simplified schematic of the melter air pollution control system (BNFL 1998a).

The melter offgas treatment system includes a film cooler, cyclone separator, two parallel trains of high-temperature filters, heat exchangers, three HEPA filters in series, and three parallel main blowers which maintain the melter at a constant negative pressure. Efficiency of the cyclone for 10-micron diameter particles is 80 to 85 percent. The high-temperature filter is designed to collect more than 99 percent of all particles greater than 0.5 microns in diameter and HEPA filters are 99.97 percent efficient for 0.3-micron particles.

E-3.2.8.5 Evaporator Treatment System. The evaporator is used to dry the scrubber brine blowdown generated from the incinerator and process non-organic liquid wastes from other areas of the plant. Brine is pumped through a thin film evaporator which disperses the liquid along the inner surface of the vessel, creating a high liquid surface area for efficient drying. Vapors from the evaporator proceed through a mesh pad demister in the housing of the evaporator vessel to remove entrained salt in the vapor phase. The salt-free vapor then enters a condenser, where a portion of the vapors are condensed and returned to the plant makeup water tank. The remainder of the vapor is returned to the incinerator air pollution control system.

E-3.3 Air Quality Impact Assessment Methodology

Distinct types of assessments have been performed to assess air quality for existing conditions and future actions. These are:

- Radiological air quality assessments, which are performed for radionuclide emissions from stationary sources;

- Nonradiological air quality assessments, which are performed for criteria and toxic air pollutant emissions from stationary (stack and diffuse) operational sources and fugitive dust and combustion product emissions associated with construction equipment and some operational sources;

- Degradation of visibility assessments, which are performed for certain criteria emissions from stationary sources; and

- Assessments of criteria pollutant emissions from mobile sources.

This section describes the methodology used in each type of air quality assessment, including the general approach to source term estimation and atmospheric dispersion modeling, as well as specific information on related assumptions, methods, and data used in the analyses.

E-3.3.1 Source Term Estimation

The type and quantity of pollutants emitted to air from a specific source, or group of sources, is often referred to as the source term. The baseline source term was compiled from INEEL emissions inventory reports (DOE-ID 1996b, 1997a) and NESHAP reports (DOE-ID 1996d, 1997b), with projected increases as described in DOE INEL EIS (Section 5-7, and Appendix F-3). The source term for each of the proposed AMWTP alternatives was developed using conservative engineering calculations based on permit applications, and project engineering design documents and material flow balance calculations (BNFL 1998a, b, and c; MK 1997). The source term for auxiliary equipment (boilers and diesel generators) was estimated using equipment specifications and emission factors from authoritative reference sources, such as the *Compilation of Air Pollution Emission Factors Volume 1* (EPA 1997, Sections 1 and 3). Estimated radionuclide emission rates are presented in Table E-3-2 for each process having the potential for significant emissions. Table E-3-3 provides detailed non-radiological emission rate estimates for individual treatment processes as well as ancillary equipment.

E-3.3.2 Radiological Assessment Methodology

This section summarizes information on the data and methods used to assess radiological conditions and dose to individuals at onsite and offsite locations due to routine emissions of radionuclides from existing and proposed INEEL facilities.

E-3.3.2.1 Model Selection and Application. The computer program GENII (Napier et al. 1988) was used to calculate doses from all pathways and modes of exposure likely to contribute significantly to the total dose from airborne releases. These are:

- External radiation dose from radionuclides in air
- External dose from radionuclides deposited on ground surfaces
- Internal dose from inhalation of airborne radionuclides
- Internal dose from ingestion of contaminated food products.

GENII incorporates algorithms, data, and methods for calculating doses to various tissues and organs and for determination of effective dose equivalent, based on the recommendations of the International Commission on Radiological Protection (ICRP), as contained in Publications 26 and 30 (ICRP 1977, 1979). This model has several technical advantages over other available methods, including the ability to assess dose from many different release scenarios and exposure pathways. In addition, it conforms to the strict quality assurance requirements of NQA-1, Basic Requirement 3 (Design Control) and Supplementary Requirement 3S-1 (Supplementary Requirements of Design Control), which includes requirements for verification and validation of computer codes.

E-3.3.2.2 Release Modeling. Releases from stacks or vents may be modeled as either elevated or ground-level releases. For this EIS, the decision whether to model a given emission point as a stack or ground-level release was based on guidelines issued by the EPA (EPA 1995a) and the National Council on Radiation Protection and Measurements (NCRP 1986). In general, if the height of the release point is less than or equal to 2.5 times the height of attached or nearby buildings, turbulent (wake and downwash) effects are assumed to influence the release, effectively lowering the release height to ground level. In some cases, stacks at existing facilities were modeled as individual release points; in other cases, sources were grouped together and treated as a single release point. For example, elevated sources at the Power Burst Facility (the Waste Experimental Reduction Facility North and South Stacks, and the Power Burst Facility Stack) were modeled as individual elevated releases. Conversely, effluents from various vents at the Naval Reactors Facility were summed and treated as a single ground-level release.

Table E-3-2. Radionuclide emission rates for individual sources (curies per year).

	Non-thermal - Glovebox		Incinerator		Vitrification		Non-thermal Zone 3		Total (abated) emissions	
Radionuclide	Unabated RF[a]=0.001	Abated FF[b]=1E-6	Unabated RF=1.0	Abated FF=1E-7	Unabated PF[c,d]=0.1 Inc.	Abated FF=1E-06	Unabated PF=0.1 Inc.	Abated FF=1E-06	Proposed Action Alt.	Non-thermal. Treat. Alt.
Am-241	7.3E-02	7.3E-08	5.4E+03	5.4E-04	5.4E+02	5.4E-04	1.6E+01	1.6E-05	1.1E-03	1.6E-05
Pu-238	6.9E-02	6.9E-08	5.1E+03	5.1E-04	5.1E+02	5.1E-04	1.5E+01	1.5E-05	1.0E-03	1.5E-05
Pu-239	4.1E-02	4.1E-08	3.0E+03	3.0E-04	3.0E+02	3.0E-04	9.0E+00	9.0E-06	6.2E-04	9.0E-06
Pu-240	9.5E-03	9.5E-09	7.0E+02	7.0E-05	7.0E+01	7.0E-05	2.1E+00	2.1E-06	1.4E-04	2.1E-06
Pu-242	6.2E-07	6.2E-13	4.6E-02	4.6E-09	4.6E-03	4.6E-09	1.4E-04	1.4E-10	9.3E-09	1.4E-10
Pu-241	9.6E-02	9.6E-08	7.1E+03	7.1E-04	7.1E+02	7.1E-04	2.1E+01	2.1E-05	1.4E-03	2.1E-05
Ba-137m	1.3E-03	1.3E-09	1.0E+02	1.0E-05	1.0E+02	1.0E-04	2.9E-01	2.9E-07	1.1E-04	3.0E-07
Cs-137	1.4E-03	1.4E-09	1.0E+02	1.0E-05	1.0E+02	1.0E-04	3.0E-01	3.0E-07	1.1E-04	3.0E-07
Sr-90	1.2E-03	1.2E-09	8.9E+01	8.9E-06	8.9E+00	8.9E-06	2.6E-01	2.6E-07	1.8E-05	2.7E-07
Y-90	1.2E-03	1.2E-09	8.9E+01	8.9E-06	8.9E+00	8.9E-06	2.6E-01	2.6E-07	1.8E-05	2.7E-07
U-233	6.1E-04	6.1E-10	4.5E+01	4.5E-06	4.5E+00	4.5E-06	1.3E-01	1.3E-07	9.2E-06	1.3E-07
Cm-244	3.2E-04	3.2E-10	2.4E+01	2.4E-06	2.4E+00	2.4E-06	7.0E-02	7.0E-08	4.9E-06	7.1E-08
H-3	1.6E-04	1.6E-04	1.2E+01	1.2E+01	1.2E+00	1.2E+00	3.5E-02	3.5E-02	1.3E+01	3.5E-02
Cs-134	6.6E-05	6.6E-11	4.9E+00	4.9E-07	4.9E+00	4.9E-06	1.5E-02	1.5E-08	5.4E-06	1.5E-08
Co-60	6.0E-05	6.0E-11	4.4E+00	4.4E-07	4.4E-01	4.4E-07	1.3E-02	1.3E-08	9.0E-07	1.3E-08

Source: BNFL 1998a.
a. RF = Release fraction from 40 CFR 61, Appendix D.
b. FF = Filtration factor (Note: These factors do not apply to H-3)
c. PF = Partition factor.
d. Vitrification emissions are based on incinerator source term, with a PF of 0.1 (except for Cs-137/Ba-137m and Cs-134, for which PF = 1.0).

Table E-3-3. Projected nonradiological emission rates for the proposed AMWTP and support equipment.[a]

Substance	Non-thermal Treatment[b] Maximum Hourly[c] g/hr	Non-thermal Treatment[b] Annual Average[d] kg/yr	Thermal Treatment[e] Maximum Hourly g/hr	Thermal Treatment[e] Annual Average kg/yr	Boilers/Heaters[f,g] Maximum Hourly g/hr	Boilers/Heaters[f,g] Annual Average kg/yr	Diesel Generators[h] Maximum Hourly g/hr	Diesel Generators[h] Annual Average kg/yr	Total Alternative Maximum Hourly g/hr	Total Alternative Annual Average kg/yr
Proposed Action										
Criteria Pollutants										
Carbon Monoxide	-[i]	-[i]	1.2E+02	9.1E+02	1.3E+02	1.0E+03	8.1E+03	4.2E+02	8.4E+03	2.3E+03
Oxides of Nitrogen	-[i]	-[i]	1.9E+03	1.4E+04	7.5E+02	5.9E+03	3.8E+04	2.0E+03	4.0E+04	2.2E+04
Sulfur Dioxide	-[i]	-[i]	2.8E+03	1.9E+04	5.9E+01	4.7E+02	2.5E+03	1.3E+02	5.4E+03	2.0E+04
Particulate Matter (PM-10)	1.6E-07	1.3E-06	1.5E-05	6.4E-05	2.4E+01	1.9E+02	2.7E+03	1.4E+02	2.7E+03	3.3E+02
Volatile Organic Compounds	6.4E+00	5.0E+01	1.5E+01	1.2E+02	2.0E+01	1.6E+02	3.0E+03	1.6E+02	3.0E+03	4.8E+02
Lead	2.4E-08	1.9E-07	4.9E-06	3.9E-05	-[i]	-[i]	-[i]	-[i]	4.9E-06	3.9E-05
Carcinogens										
Arsenic	1.5E-09	1.2E-08	2.6E-05	2.1E-04	-[i]	-[i]	-[i]	-[i]	2.6E-05	2.1E-04
Asbestos	5.0E-09	4.0E-08	-[j]	-[j]	-[i]	-[i]	-[i]	-[i]	5.0E-09	4.0E-08
Benzene	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[i]	1.2E+02	6.2E+00	1.2E+02	9.0E+00
Beryllium	1.0E-09	7.9E-09	1.0E-05	8.2E-05	-[i]	-[i]	-[i]	-[i]	1.0E-05	8.2E-05
Cadmium	1.5E-09	1.2E-08	2.6E-05	2.1E-04	-[i]	-[i]	-[i]	-[i]	2.6E-05	2.1E-04
Carbon tetrachloride	1.7E-01	1.3E+00	3.0E+00	2.3E+01	-[i]	-[i]	-[i]	-[i]	3.1E+00	2.5E+01
Chloroform	6.4E-02	5.0E-01	3.0E-01	2.3E+00	-[i]	-[i]	-[i]	-[i]	3.6E-01	2.8E+00
Chromium (hexavalent)	7.5E-11	5.9E-10	1.0E-05	8.2E-05	-[i]	-[i]	-[i]	-[i]	1.0E-05	8.2E-05
1,2-Dichloroethane (Ethylene dichloride)	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[i]	-[i]	-[i]	3.5E-01	2.7E+00
1,1-Dichloroethylene	6.4E-02	5.0E-01	3.0E-01	2.3E+00	-[i]	-[i]	-[i]	-[i]	3.6E-01	2.8E+00
Dioxin/furans (2,3,7,8 TCDD equivalent)	-[k]	-[k]	7.3E-07	5.8E-06	-[i]	-[i]	-[i]	-[i]	7.3E-07	5.8E-06
Formaldehyde	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	2.3E+02	1.2E+01	2.3E+02	1.2E+01
Methylene chloride	6.4E-02	5.0E-01	3.0E-01	2.3E+00	-[i]	-[i]	-[i]	-[i]	3.6E-01	2.8E+00
Nickel	4.5E-10	3.6E-09	1.0E-05	8.2E-05	-[i]	-[i]	-[i]	-[i]	1.0E-05	8.2E-05
Polychlorinated Biphenyls	2.9E-09	2.3E-08	8.9E-02	7.0E-10	-[i]	-[i]	-[i]	-[i]	8.9E-02	7.0E-01
Tetrachloroethylene	5.4E-01	4.3E+00	3.0E-01	2.3E+00	-[i]	-[i]	-[i]	-[i]	8.4E-01	6.7E+00
1,1,2-Trichloroethane	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[i]	-[i]	-[i]	3.5E-01	2.7E+00
Trichloroethylene	5.4E-01	4.3E+00	3.0E-01	2.3E+00	-[i]	-[i]	-[i]	-[i]	8.4E-01	6.7E+00

Table E-3-3. Projected nonradiological emission rates for the proposed AMWTP and support equipment (continued).

Substance	Non-thermal Treatment[b]		Thermal Treatment[e]		Boilers/Heaters[f,g]		Diesel Generators[h]		Total Alternative	
	Maximum Hourly[c] g/hr	Annual Average[d] kg/yr	Maximum Hourly g/hr	Annual Average Kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr
Proposed Action (Continued)										
<u>Noncarcinogens</u>										
Acetone	6.4E-02	5.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.6E-01	2.8E+00
Barium	1.5E-09	1.2E-08	1.0E-05	8.2E-05	-[i]	-[I]	-[i]	-[i]	1.0E-05	8.2E-05
Butyl alcohol	6.4E-02	5.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.6E-01	2.8E+00
Chlorine	-[i]	-[i]	1.8E+01	1.5E+02	-[i]	-[I]	-[i]	-[i]	1.8E+01	1.5E+02
Chlorobenzene	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.5E-01	2.7E+00
Chromium (trivalent)	1.4E-09	1.1E-08	1.0E-05	8.2E-05	-[i]	-[I]	-[i]	-[i]	1.0E-05	8.2E-05
Cyanide	3.6E-10	2.9E-09	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.0E-01	2.3E+00
Cyclohexane	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.5E-01	2.7E+00
2-Ethoxyethanol	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.5E-01	2.7E+00
Ethyl benzene	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.5E-01	2.7E+00
Hydrogen chloride	-[i]	-[i]	2.5E+01	1.9E+02	-[i]	-[I]	-[i]	-[i]	2.5E+01	1.9E+02
Hydrogen fluoride	-[i]	-[i]	1.4E+02	1.1E+03	-[i]	-[I]	-[i]	-[i]	1.4E+02	1.1E+03
Mercury	1.6E-09	1.3E-08	9.2E+00	7.3E+01	-[i]	-[I]	-[i]	-[i]	9.2E+00	7.3E+01
Methanol	6.4E-02	5.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.6E-01	2.8E+00
Methyl ethyl ketone	5.0E-02	4.0E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.5E-01	2.7E+00
Nitrobenzene	1.5E-02	1.2E-01	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	3.1E-01	2.5E+00
Selenium	1.5E-09	1.2E-08	7.3E+01	5.8E+02	-[i]	-[I]	-[i]	-[i]	7.3E+01	5.8E+02
Silver	1.5E-09	1.2E-08	1.0E-05	8.2E-05	-[i]	-[I]	-[i]	-[i]	1.0E-05	8.2E-05
Toluene	5.4E-01	4.3E+00	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	8.4E-01	6.7E+00
1,1,1-Trichloroethane	4.0E-01	3.2E+00	8.9E+00	7.0E+01	-[i]	-[I]	-[i]	-[i]	9.3E+00	7.3E+01
Trichloroethylene	5.4E-01	4.3E+00	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	8.4E-01	6.7E+00
1,1,2-Trichloro-1,2,2-trifluoroethane	1.7E-01	1.3E+00	3.0E+00	2.3E+01	-[i]	-[I]	-[i]	-[i]	3.1E+00	2.5E+01
Xylene	5.4E-01	4.3E+00	3.0E-01	2.3E+00	-[i]	-[I]	-[i]	-[i]	8.4E-01	6.7E+00

Table E-3-3. Projected nonradiological emission rates for the proposed AMWTP and support equipment (continued).

Substance	Non-thermal Treatment[b]		Thermal Treatment[e]		Boilers/Heaters[f,g]		Diesel Generators[h]		Total Alternative	
	Maximum Hourly[c] g/hr	Annual Average[d] kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr
Non-thermal Treatment Alternative										
<u>Criteria Pollutants</u>										
Carbon Monoxide	-[i]	-[i]	-[l]	-[l]	3.6E+01	2.8E+02	4.1E+03	2.1E+02	4.1E+03	4.9E+02
Oxides of Nitrogen	-[i]	-[i]	-[l]	-[l]	2.1E+02	1.7E+03	1.9E+04	9.8E+02	1.9E+04	2.6E+03
Sulfur Dioxide	-[i]	-[i]	-[l]	-[l]	1.7E+01	1.3E+02	1.3E+03	6.5E+01	1.3E+03	2.0E+02
Particulate Matter (PM-10)	1.6E-07	1.3E-06	-[l]	-[l]	6.7E+00	5.3E+01	1.3E+03	7.0E+01	1.3E+03	1.2E+02
Volatile Organic Compounds	6.4E+00	5.0E+01	-[l]	-[l]	5.5E+00	4.4E+01	1.5E+03	7.8E+01	1.5E+03	1.7E+02
Lead	2.4E-08	1.9E-07	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	2.4E-08	1.9E-07
<u>Carcinogens</u>										
Arsenic	1.5E-09	1.2E-08	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	1.5E-09	1.2E-08
Asbestos	5.0E-09	4.0E-08	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	5.0E-09	4.0E-08
Benzene	5.0E-02	4.0E-01	-[l]	-[l]	-[i]	-[I]	6.0E+01	3.1E+00	6.0E+01	3.5E+00
Beryllium	1.0E-09	7.9E-09	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	1.0E-09	7.9E-09
Cadmium	1.5E-09	1.2E-08	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	1.5E-09	1.2E-08
Carbon tetrachloride	1.7E-01	1.3E+00	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	1.7E-01	1.3E+00
Chloroform	6.4E-02	5.0E-01	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	6.4E-02	5.0E-01
Chromium (hexavalent)	7.5E-11	5.9E-10	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	7.5E-11	5.9E-10
1,2-Dichloroethane (Ethylene dichloride)	5.0E-02	4.0E-01	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	5.0E-02	4.0E-01
1,1-Dichloroethylene	6.4E-02	5.0E-01	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	6.4E-02	5.0E-01
Dioxin/furans (2,3,7,8 TCDD equivalent)	-[i]	-[i]	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	-[i]	-[i]
Formaldehyde	-[i]	-[i]	-[l]	-[l]	-[i]	-[I]	1.2E+02	6.0E+00	1.2E+02	6.0E+00
Methylene chloride	6.4E-02	5.0E-01	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	6.4E-02	5.0E-01
Nickel	4.5E-10	3.6E-09	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	4.5E-10	3.6E-09
Polychlorinated Biphenyls	2.9E-09	2.3E-08	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	2.9E-09	2.3E-08
Tetrachloroethylene	5.4E-01	4.3E+00	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	5.4E-01	4.3E+00
1,1,2-Trichloroethane	5.0E-02	4.0E-01	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	5.0E-02	4.0E-01
Trichloroethylene	5.4E-01	4.3E+00	-[l]	-[l]	-[i]	-[I]	-[i]	-[i]	5.4E-01	4.3E+00

Table E-3-3. Projected nonradiological emission rates for the proposed AMWTP and support equipment (continued).

Substance	Non-thermal Treatment[b]		Thermal Treatment[e]		Boilers/Heaters[f,g]		Diesel Generators[h]		Total Alternative	
	Maximum Hourly[c] g/hr	Annual Average[d] kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr	Maximum Hourly g/hr	Annual Average kg/yr
Non-thermal Treatment Alternative (Continued)										
Noncarcinogens										
Acetone	6.4E-02	5.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	6.4E-02	5.0E-01
Barium	1.5E-09	1.2E-08	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	1.5E-09	1.2E-08
Butyl alcohol	6.4E-02	5.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	6.4E-02	5.0E-01
Chlorine	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]
Chlorobenzene	5.0E-02	4.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.0E-02	4.0E-01
Chromium (trivalent)	1.4E-09	1.1E-08	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	1.4E-09	1.1E-08
Cyanide	3.6E-10	2.9E-09	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	3.6E-10	2.9E-09
Cyclohexane	5.0E-02	4.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.0E-02	4.0E-01
2-Ethoxyethanol	5.0E-02	4.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.0E-02	4.0E-01
Ethyl benzene	5.0E-02	4.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.0E-02	4.0E-01
Hydrogen chloride	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]
Hydrogen fluoride	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]
Mercury	1.6E-09	1.3E-08	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	1.6E-09	1.3E-08
Methanol	6.4E-02	5.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	6.4E-02	5.0E-01
Methyl ethyl ketone	5.0E-02	4.0E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.0E-02	4.0E-01
Nitrobenzene	1.5E-02	1.2E-01	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	1.5E-02	1.2E-01
Selenium	1.5E-09	1.2E-08	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	1.5E-09	1.2E-08
Silver	1.5E-09	1.2E-08	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	1.5E-09	1.2E-08
1,1,1-Trichloroethane	4.0E-01	3.2E+00	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	4.0E-01	3.2E+00
Trichloroethylene	5.4E-01	4.3E+00	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.4E-01	4.3E+00
1,1,2-Trichloro-1,2,2-trifluoroethane	1.7E-01	1.3E+00	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	1.7E-01	1.3E+00
Toluene	5.4E-01	4.3E+00	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.4E-01	4.3E+00
Xylene	5.4E-01	4.3E+00	-[i]	-[i]	-[i]	-[i]	-[i]	-[i]	5.4E-01	4.3E+00

Table E-3-3. Projected nonradiological emission rates for the proposed AMWTP and support equipment (continued).

[a] Based on BNFL 1998c.
[b] Does not include fugitive emissions (2.4 g/hr and 19 kg/yr) resulting from grout preparation and glass former mixing.
[c] Short-term impacts (e.g., noncarcinogenic toxic air pollutants, carbon monoxide, etc.) are evaluated using maximum hourly emission rates.
[d] Long-term impacts (e.g., carcinogens and criteria pollutant annual average concentrations) are evaluated using the annual average emission rate which is based on an operating schedule of 330 days per year.
[e] Thermal treatment assumes a feed rate of 650 lb/hr for the incinerator and 289 lb/hr for the vitrifier.
[f] Boilers and hot water heater are assumed to operate 330 days per year. Under the Proposed Action or Treatment and Storage Alternative, there would be two steam boilers, two hot water boilers and one water heater operating concurrently.
[g] Under the Non-thermal Treatment Alternative, two heating boilers (but no process boilers) and one hot water heater would operate concurrently.
[h] Diesel generators are assumed to operate for 52 hours per year. Two generators would be used under the Proposed Action or Treatment and Storage Alternative, while only one would operate under the Non-thermal Treatment Alternative.
[i] Substance is not emitted in significant amounts by this process or equipment.
[j] Asbestos-containing waste would not be treated in the incinerator.
[k] Dioxin and furans emissions are limited in accordance with the proposed MACT standard for combustion of hazardous waste, and have been set equal to that limit. They are expressed in terms of equivalency to the compound, 2,3,7,8 TCDD.
[l] Thermal treatment is not part of this alternative.

The proposed AMWTP main stack is about 1.5 times the height of the building. While this does not strictly meet the general guideline of 2.5 times the building height to characterize the release as elevated, various additional factors were considered, which together indicated that the release is more appropriately characterized as elevated. The include: (1) the actual stack height of 90 feet is well above ground level, (2) the combined effects of discharge velocity (20 m/s) and thermal induced buoyancy of the offgas, which tend to increase the effective stack height, and (3) design analyses which resulted in an optimization of stack height based on good engineering practice to minimize building-induced cavity effects.

E-3.3.2.3 Meteorological Data. The atmospheric transport modeling performed as part of these radiological assessments was based on actual meteorological conditions measured at eight different locations at the INEEL. In particular, the data files prepared for these assessments were derived from observations at INEEL weather stations over the period 1987 through 1991. Radionuclide emissions from the proposed AMWTP main stack were modeled using meteorological data from the 200-foot level of the Grid III monitoring station, which is located about 8 miles northeast of the proposed AMWTP site.

E-3.3.2.4 Receptor Locations. Doses were assessed for individuals located at the onsite and offsite locations of highest predicted dose and for the surrounding population, as described below.

***Maximally Exposed Individual*.** The offsite individual whose assumed location and habits are likely to result in the highest dose is referred to as the maximally exposed individual (MEI). The location of the maximally exposed individual was identified on the basis of the source-receptor distance and direction combination that yielded the highest predicted offsite dose. In the DOE INEL EIS, radiation dose was calculated for the minimum distance from each of the major INEEL source areas to the site boundary for each of the 16 compass directions. Since this location was assessed separately for emissions from each of the INEEL areas, the maximally exposed individual receptor locations are merely points on the INEEL boundary and do not correspond to any actual residences or quarters. These maximum impacts were conservatively summed to derive cumulative impacts, although they occur at spatially distant locations. (The actual MEI locations for five of the major INEEL facilities are all located along a segment of the southern boundary, southwest of the facilities in question.) Although unrealistic, this cumulative MEI assessment process serves to establish the upper-bounding dose. Despite the inherent conservatism, the results obtained were low, and further resolution of the actual MEI location and dose was not necessary.

In this EIS, the dose to the MEI from existing facilities is taken from the annual NESHAP compliance evaluations (DOE-ID 1996d, 1997b). The highest of the most recent two years is used. The MEI dose estimated for the Preferred Alternative from the DOE INEL EIS is assumed to represent projected increases to the current dose. The MEI dose from proposed AMWTP emissions was modeled using GENII and then added to the baseline dose and projected increases to determine the cumulative offsite individual dose.

Population Dose. In the DOE INEL EIS, dose was assessed for the collective population residing in a circular area defined by a radius of 80 kilometers extending out from each major INEEL facility. Population data used were based on 1990 census data provided by the U.S. Census Bureau. For projects associated with DOE INEL EIS alternatives and for projects expected to become operational before June 1, 1995, growth projections for the counties surrounding INEEL were applied. These growth estimates are approximately 10 percent per decade. The period covered by the DOE INEL EIS analysis extends to the year 2005, and the population doses reported in Section 5.7, Air Resources, of Volume 2 of this EIS are the highest obtained for any year throughout this period.

For this EIS, the population dose assessment applies only to the population residing within 80 kilometers of the RWMC, which is the proposed AMWTP location. A maximum growth rate of 6 percent per annum has been assumed for the proposed AMWTP population dose assessment.

***INEEL Worker*.** INEEL workers may be exposed to radiation attributable to INEEL sources both as a direct result of job performance (such as work within a radiologically controlled area) and incidentally (such as from airborne releases from facilities within their work area, as well as more distant sources within the INEEL). Incidental exposure due to onsite concentrations of radionuclides were assessed in the DOE INEL EIS (for existing sources and future projects) and in this EIS (for the proposed AMWTP). (Direct, job-related occupational exposure is discussed in Sections 4.12 and 5.12, Health and Safety, of this EIS and Volume 2, Part A of the DOE INEL EIS.) An individual who would receive the highest dose due to incidental exposures is termed the maximally exposed worker. The dose to the maximally exposed worker was assessed using the general methodology described in previous sections. One major difference is the fact that the worker dose calculations did not include the food ingestion pathway, since workers do not consume food products grown onsite.

Although both EIS onsite dose assessments used the GENII code, the methodology used for this EIS differed somewhat from the DOE INEL EIS assessments. The proposed AMWTP dose assessment was performed by first generating an atmospheric dispersion factor using the Industrial Source Complex (ISC-3) code described in Section E-3.3.3.1 below. A finely spaced receptor grid (50-meter spacing) was used to identify the area of highest predicted onsite dose. The dispersion factor for that receptor location was manually entered as input to GENII, which was then executed to calculate dose. This level of refinement was not possible in the DOE INEL EIS, because of the large number of sources involved, the large areas over which the sources were distributed, and the lack of detailed facility descriptions for many of the future sources.

E-3.3.3 Nonradiological Assessment Methodology

Air pollutant levels have been estimated by application of air dispersion computer models that incorporate mathematical functions to simulate transport of pollutants in the atmosphere. The modeling methodology conforms to that recommended by the EPA (EPA 1995a) and the State of Idaho (IDHW 1997) for such applications. The models and application methodology are designed to be conservative; that is, they employ data and algorithms designed to prevent underestimating the pollutant concentrations that would actually exist. In general, the methods used to assess consequences of proposed actions were identical to those used in the baseline assessments. Minor exceptions (such as the use of refined versus screening-level modeling) will be noted where applicable. The primary objective of the assessments is to estimate nonradiological pollutant concentrations and other impacts in a manner that facilitates comparison between alternative courses of action, while also providing an indication of compliance with applicable standards or guidelines.

The types of pollutants assessed include the criteria pollutants and certain types of toxic air pollutants. Criteria pollutant concentrations were estimated for locations and over periods of time corresponding to State of Idaho and NAAQS. Since these standards apply only to ambient air (that is, locations to which the general public has access), criteria pollutant concentrations were assessed for offsite locations and public roads traversing the INEEL. The nonradiological assessment did not quantitatively assess impacts related to ozone formation because (1) volatile organic compound emission levels are below the significance level designated by the State of Idaho; (2) no simple, well-defined method exists to assess ozone formation potential (Wilson 1993); and (3) while the Idaho Division of Environmental Quality has no ozone monitoring data from the vicinity, it is not aware of problematic ozone levels in the area (Andrus 1994). This is confirmed by recent data collected by the NPS at Craters of the Moon Wilderness Area where no exceedances of the primary ozone standard have been reported (DOI 1994).

Offsite levels of carcinogenic and noncarcinogenic toxic air pollutants were evaluated on the basis of annual average emission rates and compared to annual average standards (increments) recently promulgated by the State of Idaho. Toxic air pollutants were also assessed for onsite locations because of potential exposure of workers to these hazardous substances. Onsite levels of specific toxins were calculated using maximum hourly emission rates and compared to occupational exposure limits set for these substances by either the Occupational Safety and Health Administration (OSHA) or the American Conference of Governmental Industrial Hygienists (ACGIH) (the lower of the two limits is used).

E-3.3.3.1 Model Description and Application. The EPA Industrial Source Complex-3 (ISC-3 short-term version) computer code (EPA 1995b) was used to evaluate AMWTP alternatives. The ISC-3 model incorporates site-specific data (such as meteorological observations from INEEL weather stations), and takes into account effects such as stack tip downwash and turbulence induced by the presence of nearby structures. In addition, the model accommodates multiple sources and calculates concentrations for user-specified receptor locations. Concentrations were calculated over a range of durations, from one-hour maximum values to annual averages. In summary, dispersion modeling using ISC-3 allows for a reasonable prediction of the impacts of proposed facilities and, therefore, is ideally suited for use in the EIS process.

The analyses performed for the DOE INEL EIS which served to establish the baseline used for this AMWTP EIS made use of some additional models as described in Appendix F-3 of the DOE INEL EIS. These models are comprised of the earlier version of ISC (ISC-2). SCREEN, a screening-level model was used in many cases where a source's contribution to toxic air pollutant concentrations was expected to be minimal (that is, well below acceptable standards). The EPA-recommended Fugitive Dust Model (Winges 1991) was used to assess fugitive dust impacts. SCREEN and the Fugitive Dust Model are not used in this EIS.

E-3.3.3.2 Emission Parameters. The use of air dispersion models requires emission parameters, such as stack height and diameter and exhaust gas temperature and flow rate; size of area (for example, disturbed areas related to construction sources); and pollutant emission rates. The DOE INEL EIS analysis obtained emission parameter data from the INEEL air emissions inventories discussed above, as well as from project design documents.

The principal source of emissions at the proposed AMWTP will be the main stack, which is actually an assemblage of several individual smaller stacks (or flues) shrouded by a wind screen. The offgas streams from the incinerator, vitrifier/melter, glovebox and containment areas, and process area heating, ventilation and air conditioning (HVAC) systems each pass through separate air pollution control systems and are then exhausted through separate flues. These flues vary in diameter, but each extends to the top of the 27.5 meter (90-foot) main stack (MK 1997). A diagram of the main stack showing these emission points is presented in Figure E-3-5. In addition to the main stack, for the Proposed Action and Treatment and Re-Storage Alternatives, nonradiological pollutants will be emitted from six propane-fueled water boilers (four of which could operate at any one time), one hot water heater, and two diesel-fueled emergency generators. With the Non-Thermal Treatment Alternative, nonradiological pollutants will be emitted from three propane-fueled water boilers (only two would operate at any one time), one hot water heater, and one diesel-fueled emergency generator. The boiler and heater stacks would be located at a utility building situated about 70 feet south of the proposed AMWTP main building. The generators will be located near the southeast and southwest corners of the main building. The parameter values used for the proposed AMWTP stacks are provided in Table E-3-4.

E-3.3.3.3 Meteorological Data. Emissions from the proposed AMWTP main stack were modeled using meteorological data from the 200-foot level of the Grid III monitoring station, which is located about 8 miles northeast of the proposed AMWTP site. Emissions from the diesel generators and boilers were modeled using data from the 33-foot level of the Grid III monitoring station. The meteorological data used contained hourly observations of wind speed, direction, temperature, and stability class for the years 1991 and 1992.

Data required for the calculation of mixing height are currently being collected at the INEEL but are not available for these periods. Therefore, default mixing heights were used. For short-term assessments, a value of 150 meters, which represents the lowest value measured at the INEEL, was used. For annual average evaluations, 800 meters was used. This value has been calculated by the National Oceanic and Atmospheric Administration and is recommended for use in dispersion modeling assessments (Sagendorf 1991). Each case was assessed separately using data from these years, and the highest of the predicted concentrations was selected.

E-3.3.3.4 Receptor Locations. The ISC-3 Model is capable of determining air quality impacts at receptor locations using either a grid layout pattern or user-specified receptor points. Based on modeling efforts performed previously, maximum impacts at ambient receptor locations are expected to occur either (1) along public roads that traverse the INEEL or (2) along the INEEL boundary. No points of maximum impact are expected to occur at locations beyond the INEEL boundary. Thus, only discrete receptors at those locations (as opposed to a gridded array) have been used for regulatory air assessments at those locations and at Craters of the Moon Wilderness Area. (Gridded arrays were used, however, in modeling performed to identify the areas where fine spacing of discrete receptors points is necessary.)

The receptor locations for the AMWTP dispersion modeling were based on the receptor array developed for the DOE INEL EIS (described in Appendix F-3 of that document). This array was modified to include additional receptor locations and eliminate those receptor locations that are clearly beyond the range of maximum impact. Also, the elevation of each receptor location was added.

AAC were calculated for each location specified in the receptor array; however, the regulatory compliance evaluations for carcinogenic toxic air pollutants were performed only for site boundary locations (and not transportation corridors), as provided by IDAPA 210.036 (IDHW 1997). Criteria and noncarcinogenic toxic air pollutants were assessed at all ambient air locations. PSD increment consumption was also assessed for the INEEL area and Craters of the Moon Wilderness Area, the Class I area nearest the INEEL. Class I area increments were assessed at discrete receptor locations along the eastern and northern boundaries at intervals of 1,640 feet.

Concentrations of toxic air pollutants for which occupational exposure standards exist were assessed at locations within the RWMC to characterize potential levels to which workers may be subjected. For these assessments, a grid centered on the proposed AMWTP main stack and extending to the boundary of the RWMC area was developed. This grid uses 164.5-foot spacing in order to identify the onsite location of highest impact.

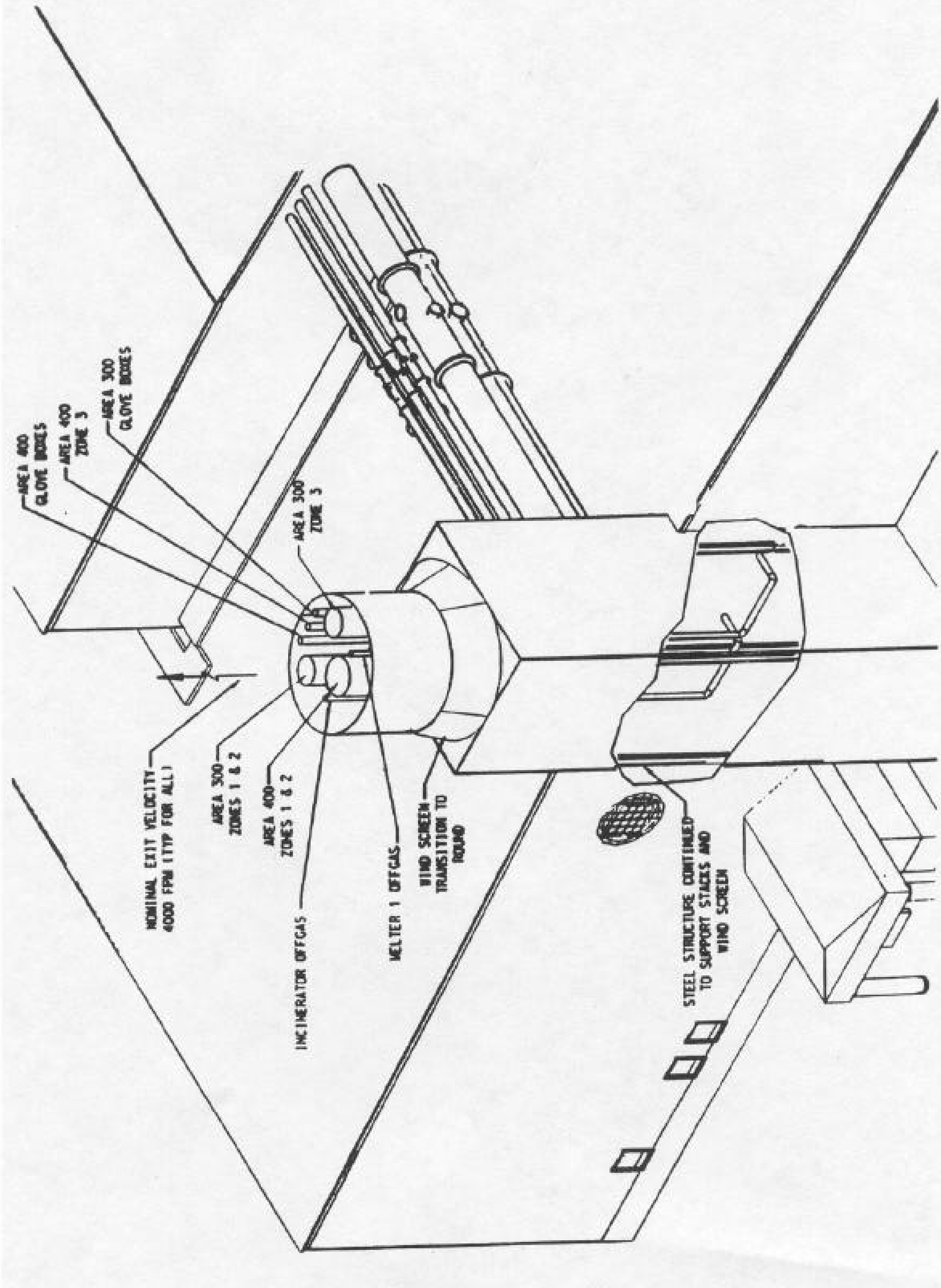

Figure E-3-5. Diagram of main stack flues (MK 1997).

Table E-3-4. AMWTP Stack Exit Parameters.

Stack name	Stack Exit Conditions Height (ft)	Velocity (ft/min)	Diameter (inches)	Temp. (°F)	Flowrate (ACFM)	Emission sources
Melter	90	4,000	2.5	120	136	Melter
Incineration	90	4,000	9.9	187	2,140	Incinerator
Non-thermal Zone 1&2 Extract	90	4,000	38.0	86	31,500	None
Non-thermal Zone 3 Extract	90	4,000	37.1	86	30,000	Non-thermal handling other than glovebox
Non-thermal Glovebox Extract	90	4,000	9.6	86	2,000	Analytical lab and sample extraction gloveboxes
Thermal Zone 1&2 Extract	90	4,000	52.4	86	60,000	None
Thermal Zone 3 Extract	90	4,000	9.6	86	2,000	None
Thermal Glovebox Extract	90	4,000	9.6	86	2,000	None
Steam Boiler Exhaust (1)	68	1,914	22.0	450	5,050	Steam Boiler
Steam Boiler Exhaust (2)	68	1,914	22.0	450	5,050	Steam Boiler
HVAC Boiler Exhaust (1)	68	1,722	16.0	450	2,400	HVAC Boiler
HVAC Boiler Exhaust (2)	68	1,722	16.0	450	2,400	HVAC Boiler
Potable Hot Water Heater Exhaust	68	582	12.0	400	460	Potable Hot Water Heater
Diesel Generator (1)	16	6,888	6.0	934	1,352	Diesel engine
Diesel Generator (2)	16	6,888	6.0	934	1,352	Diesel engine

Sources: MK 1997; BNFL 1998c.

E-3.3.3.5 Impacts on Visibility. Atmospheric visibility has been specifically designated as an air quality-related value under the 1977 PSD Amendments to the CAA. Therefore, in the assessment of proposed projects that invoke PSD review (see Section F-3.1.1.2), potential impacts to visibility must be evaluated and shown to be acceptable in designated Class I areas and associated integral vistas. Craters of the Moon Wilderness Area, located approximately 12 miles southwest of the INEEL, is the only Class I area in the Eastern Snake River Plain. However, recognizing the importance of the scenic views in and around the Fort Hall Indian Reservation, additional analyses were performed for this location.

The EPA has designed methodologies and developed computer codes to estimate potential visual impacts due to emissions of proposed sources. The methodologies include three levels of sophistication. Level-1 is designed to be very conservative; it uses assumptions and simplifying methodologies that will predict plume visual impacts larger than those calculated with more realistic input and modeling assumptions. This conservatism is achieved by the use of worst-case meteorological conditions, including extremely stable (Class F) conditions coupled with a very low wind speed (3 feet per second) persisting for 12 hours, with a wind direction that would transport the plume directly adjacent to a hypothetical observer in the Class I or scenic area. The Level-1 analysis is implemented using the computer code VISCREEN to calculate the potential visual impact of a plume of specified emissions for specific transport and dispersion conditions. If screening calculations using VISCREEN demonstrate that during worst-case meteorological conditions a plume is either imperceptible or, if perceptible, is not likely to be considered objectionable, further analysis of plume visual impact would not be required (EPA 1992). Level-2 visual impact modeling employs more site-specific information than that of Level-1. It is still conservative and designed to overestimate potential visibility deterioration. Level-3 visual impact modeling is more intensive in scope and designed to provide a more realistic treatment of plume visual impacts. In both the DOE INEL EIS and this EIS, the Level-1 VISCREEN analyses were performed to ensure conservatism.

Because within a range of wavelengths, a measure of contrast must recognize both intensity, and perceived color, the VISCREEN model determines whether a plume is visible by calculating contrast (brightness) and color contrast. Contrast is calculated at three visual wavelengths to characterize blue, green, and red regions of the visual spectrum to determine if a plume will be brighter, darker, or discolored compared to its viewing background. If plume contrast is positive, the plume is brighter than its viewing background; if negative, the plume is darker. To address the dimension of color as well as brightness, the color contrast parameter, termed “delta E”, is used as the primary basis for determining the perceptibility of plume visual impacts in screening analyses. Delta E provides a single measure of the difference between two arbitrary colors as perceived by humans. If contrasts are different at different wavelengths, the plume is discolored. If contrasts are all zero, the plume is indistinguishable from its background.

In order to determine whether a plume has the potential to be perceptible to observers under reasonable worst-case conditions, the VISCREEN model calculates both delta E and contrast for two assumed plume-viewing backgrounds: the horizon sky and a dark terrain object. Results are provided for two assumed worst-case sun angles (to simulate forward and backward scattering of light), with the sun in front and behind the observer, respectively. If either of two screening criteria is exceeded, more comprehensive and realistic analyses should be carried out. The first criterion is a delta E value of 2.0; the second is a green contrast value of 0.05. Regional haze, which is caused by multiple sources throughout a region, is not calculated or estimated with the VISCREEN model.

The VISCREEN model was used to evaluate the potential visual impact of the proposed AMWTP and cumulative emissions of proposed sources at the INEEL on Craters of the Moon Wilderness Area and the Fort Hall Indian Reservation, in recognition of the importance of scenic views in and around each of these areas. For this assessment, the potential impact of incremental emissions of particulate matter and oxides of nitrogen associated with AMWTP alternatives was evaluated using maximum short-term (hourly) emission rates of particulates and nitrogen oxides and minimum and maximum distances from the source to the Class I area and Reservation. Cumulative impacts were estimated by adding impacts for each alternative to those of proposed projects associated with the baseline of the DOE INEL EIS (excluding IWPF). Current operations were considered in the baseline [that is, the impact of current emission levels is monitored at Craters of the Moon Wilderness Area, resulting in a 144-mile value for annual average visual range]. All emission sources were included except construction emissions and emergency diesel generators, which are not evaluated in a PSD assessment.

The EPA recommends default values for various model parameters. In this analysis, default values were used for all parameters with the exception of background ozone concentration. A value of 0.051 parts per million was assigned as a representative regional value (DOI 1994, Notar 1998b). A site-specific annual average background visual range, estimated to be 144 miles based on monitoring programs conducted by the NPS at Craters of the Moon Wilderness Area (Notar 1998a), was also used.

E–4 OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

This appendix describes the method used and presents the key data required for evaluating the health effects reported in this EIS. The methods presented here are organized under two broad categories: (1) health impacts from effluent releases and (2) normal workplace hazards. The first category includes effluent releases of radioactivity to air and water and addresses health effects to both the public and workers. Sufficient detail on health effects of carcinogenic and toxic chemicals is provided in Section 5.12, Occupational and Public Health and Safety, and additional detail is not provided in this appendix. The second category includes radiological and nonradiological hazards to workers at the AMWTP facility in the normal conduct of their jobs.

E–4.1 Radiological Health and Safety

Estimated health effects from radionuclides are based on the 1990 recommendations of the ICRP (ICRP 1991). These risk factors are presented in Table E-4.1-1.

In the interest of clear and consistent presentation and to allow ready comparison with health impacts from other sources, such as chemical carcinogens, the measure of impact used for evaluation of potential radiation exposures in this EIS is risk of fatal cancer. Population effects are reported as collective radiation dose (in person-rem) and the estimated number of fatal cancer in the affected population. The maximum individual effects are reported as individual radiation dose (in rem) and the estimated lifetime probability of fatal cancer. Other effects, such as nonfatal cancer and genetic effects, are presented in Table E-4.1-1 for informational purposes.

Table E-4.1-1. Risk of fatal cancer and other health effects from exposure to radiation.[a]

Receptor	Fatal cancer	Nonfatal cancer	Genetic effects	Total detriment
Worker	4.0E-04	8.0E-05	8.0E-05	5.6E-04
General public	5.0E-04	1.0E-04	1.3E-04	7.3E-04

a. Units when applied to an individual are “lifetime probability of cancer per rem of radiation dose.” Units when applied to a population of individuals are “excess number of cancer per person-rem of radiation dose.” Genetic effects apply to population, not individuals.

Human health effects associated with radionuclide emissions from the AMWTP have been calculated for (1) a worker at the location of highest predicted radioactivity level, (2) the MEI at an offsite location, and (3) the entire population (adjusted for future growth) within an 80-kilometer radius of each source of emission within the INEEL. Doses and associated human health effects are assessed for AMWTP emissions under each proposed alternative and are added to current (baseline) doses and human health impacts and projected increases as a result of other future INEEL facilities to determine cumulative radiological impacts. Projected increases are assumed to be represented by dose and human health impact estimates for the DOE INEL EIS (DOE 1995) Preferred Alternative. However, some modification to the baseline and foreseeable dose and human health impacts were necessary (see Appendix E-3, Air Resources) to remove contributions from facilities that would not operate under the proposed alternatives. Tables E-4.1-2 and E-4.1-3 present these annual and operating lifetime doses and associated human health impacts, respectively.

The principal pathway by which the public may be exposed to radioactivity is through releases to the atmosphere. Radiation doses to members of the public from airborne releases at INEEL are calculated annually using information from the Radioactive Waste Management Information System

ID 1996d, 1997c). Table E-4.1-4 presents data for 1995 and 1996. As Table E-4.1-4 indicates, the offsite radiation dose to any member of the public from normal operations is substantially less than 1 millirem per year for both periods. Current regulations limit releases of airborne radioactivity from DOE facilities to no more than 10 millirem per year to any member of the public.

Table E-4.1-2. Summary of radiation dose and human health impacts associated with airborne emissions from the AMWTP.

Receptor	Baseline		Projected		AMWTP		Cumulative	
	Dose millirem	Risk [a] (fatality)	Dose millirem	Risk [a] (fatality)	Dose millirem	Risk [a] (fatality)	Dose millirem	Risk [a] (fatality)
No Action Alternative								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.0	-	0.23	9.20E-08
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.0	-	0.14	7.00E-08
Population [b]	0.085	4.25E-05	0.41	2.05E-04	0.0	-	0.50	2.50E-04
Proposed Action Alternative								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.73	2.92E-07	0.96	3.84E-07
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.11	5.50E-08	0.25	1.25E-04
Population [b]	0.085	4.25E-05	0.41	2.05E-04	0.056	2.80E-05	0.55	2.75E-04
Non-Thermal Treatment Alternative								
MEI Onsite	0.21	8.40E-08	0.023	9.20E-09	0.003	1.20E-09	0.24	9.60E-08
MEI Offsite	0.031	1.55E-08	0.11	5.50E-08	0.0017	8.50E-10	0.14	7.00E-08
Population [b]	0.085	4.25E-05	0.41	2.05E-04	0.00037	1.85E-07	0.50	2.50E-04

a. The risk fatality for MEI is based on annual dose and one individual, the population risk is based on annual dose and total population of 82,000 within 80 kilometer of the site.
b. The population dose is in person-rem per year.

Table E-4.1-3. Summary of radiation dose and human health impacts associated with airborne emissions over the projected operating lifetime of the AMWTP.[a]

Receptor	13-year facility lifetime		30-year facility lifetime	
	Dose	Risk (fatality)	Dose	Risk (fatality)
Proposed Action				
MEI Onsite	9.5 millirem	3.80E-06	22 millirem	8.80E-06
MEI Offsite	1.5 millirem	7.50E-07	3.4 millirem	1.70E-06
Population	0.65 person-rem [b]	3.25E-04	1.6 person-rem [c]	8.00E-04
Non-Thermal Treatment Alternative				
MEI Onsite	0.039 millirem	1.56E-08	[d]	[d]
MEI Offsite	0.023 millirem	1.15E-08	[d]	[d]
Population	0.0043 person-rem [b]	2.15E-06	[d]	[d]
Treatment and Storage Alternative				
MEI Onsite	9.5 millirem	3.80E-06	22 millirem	8.80E-06
MEI Offsite	1.5 millirem	7.50E-07	3.4 millirem	1.70E-06
Population	0.65 person-rem [b]	3.25E-04	1.6 person-rem [c]	8.00E-04

a. Data for dose and lifetime from Table 5.7-4 of Section 5.7, Air.
b. The population dose and risk is based on total population of 82,000.
c. The population dose and risk is based on total population of 89,000.
d. AMWTP would not operate beyond 13 years under this alternative.

Table E-4.1-4. Estimated doses to members of the public from INEEL airborne releases for years 1995 and 1996.

Year	Maximally exposed individual (millirem)	Population dose (person-rem)[a]
1995	0.018	0.3
1996	0.031	NA[b]

a. Population dose from DOE 1995.
b. NA = Not available.

Based on the nature of the work at the INEEL, occupational radiation exposure for some workers will inevitably be above background levels. Natural background radiation dose in the vicinity of INEEL site, Snake River Plain (DOE-ID 1991a), are presented in Table E-4.1-5. More recent background radiation levels of approximately 360 mrem/year have been reported (see Section 4.7, Air Resources). The radiation protection program required by regulation and DOE orders is designed to ensure that no worker receives doses larger than the applicable limits and that worker doses are kept as low as reasonably achievable.

Workers at the RWMC may be exposed either internally or externally to radiation. Internal exposure occurs when radioactive materials are deposited in the body through inhalation, ingestion, or absorption through intact skin or wounds in the skin. External exposures in the workplace are those received from radiation-emitting sources outside the body. Table E-4.1-6 presents the collective total effective dose equivalent (which includes both internal and external doses) for individual workers with measurable dose for the DOE complex, including contractor and government workers, the INEEL, and the RWMC. The statistics for the DOE complex and INEEL are from the DOE Occupational Radiation Exposure report (DOE 1996b). The 1995 information regarding the RWMC is from Parrish (1998).

Table E-4.1-5. Estimated natural background radiation dose for the Snake River Plain.

Source	Annual effective dose equivalent (millirem)
	External
Terrestrial	75
Cosmic	39
Subtotal	114
	Internal
K-40 and others	40
Inhaled nuclides [a]	200
Subtotal	240
TOTAL	354

Source: DOE-ID 1991a.

a. The dose from inhaled radionuclides is due primarily to short-lived decay products from radon and varies widely with geographic location. The value represents the United States population average.

Table E-4.1-6. Collective total effective dose equivalent (TEDE) of individuals with measurable dose for the DOE Complex, INEEL, and RWMC.

Year	Site	Total workers, DOE and contractors	Total monitored workers	Total monitored with measurable dose	Collective dose (person-rem)	Average measurable dose (rem)
	DOE	183,546	119,770	31,326	2,574	0.082
1991	INEEL	-[a]	-	-	162	-
	RWMC	-	-	-	-	-
	DOE	191,036	123,711	29,414	2,295	0.078
1992	INEEL	-	-	1,004	87	0.082
	RWMC	-	-	15	0.87	0.058
	DOE	194,547	127,042	25,095	1,644	0.066
1993	INEEL	-	-	1,175	235.5	0.200
	RWMC	-	-	33	2.03	0.062
	DOE	184,073	116,511	25,390	1,643	0.065
1994	INEEL	-	-	1,659	236.8	0.143
	RWMC	-	-	56	7.1	0.127
	DOE	172,178	127,276	23,613	1,840	0.078

1995	INEEL	-	-	1,501	284	0.189
	RWMC	-	-	51	6.4	0.125

[a.] "- " represents no data available.

Reported doses resulting from normal operations for a recent four-year (1992-1995) period averaged to 72, 154, and 93 millirem for the DOE complex, INEEL, and RWMC, respectively. The average doses for RWMC change to 81 millirem when years 1996 and 1997 get included in the statistic. Table E-4.1-7 presents the total measured dose and the number of radiation workers.

Table E-4.1-7. RWMC total measured dose.[a]

Year	Number of radiation workers	Total dose (rem)	Average dose (rem)
1992[b]	15	0.874	0.058
1993[b]	33	2.030	0.062
1994[b]	56	7.135	0.127
1995	51	6.353	0.125
1996	78	4.439	0.057
1997	66	3.777	0.057

a. Data from INEEL radiation dosimetry system area radiation dose report.
b. For all years, the total dose includes all Environmental Restoration and Waste Management facilities, which are RWMC, Waste Experimental Reduction Facility (WERF), and Waste Reduction Operation Complex.

E-4.2 Nonradiological Hazards

The primary source of information on nonradiological hazards to the workers at the INEEL are reports of occupational injuries. Statistics regarding the injury, illness, and fatality rates for the entire DOE complex, INEEL, and RWMC are presented in Table E-4.2-1. The information for the DOE complex and INEEL are from the DOE Office of Environmental Safety and Health, Technical Information System web site [http://tis.eh.doe.gov/docs/oipds/oipds964/]. Statistics for the RWMC were obtained from an INEEL occupational health representative (Kavaran 1998). These data include construction workers in addition to operation and maintenance workers.

The calculated rates from Table E-4.2-1 are used to estimate the annual average injury/illness and fatalities based on the annual average number workers assuming 200,000 hours worked. The rate calculation is based on the approach used in DOE reports. The complete methodology can be found at the following web site [http://tis.eh.doe.gov/systems/doe_injury/rates.html]. The equations for calculating the incidence and fatality rates are as follows:

Incidence Rate per 200,000 hours = (Number of Injuries and Illnesses x 200,000 hours)/(Employee Hours Worked)

Fatality Rate per 200,000 hours = (Number of Fatalities x 200,000 hours)/(Total Hours Worked).

Table E-4.2-1. DOE Complex, INEEL, and RWMC injury, illness, and fatality statistics.

Year	Site	Total employees	Total work hours	Recordable cases	Recordable case rate	Total fatalities	Lost workday cases	Lost workday case rate[a]	Lost workdays	Lost workday rate[a]
1992	DOE	190,748	3.63E+08	6,858	3.8	10	3,209	1.8	97,827	54.0
	INEEL	9,544	1.76E+07	324	3.7	0	156	1.8	3,090	35.2
	RWMC	-[b]	-	1	-	0	-	-	1	-
1993	DOE	192,528	3.66E+08	6,737	3.7	3	2,999	1.6	90,453	49.5
	INEEL	9,042	1.72E+07	281	3.3	0	139	1.6	2.820	32.8
	RWMC	-	-	0	-	0	-	-	0	-
1994	DOE	183,574	3.49E+08	6.282	3.6	12	3,008	1.7	88,111	50.5
	INEEL	8,384	1.59E+07	250	3.1	0	110	1.4	1,823	22.9

	RWMC	-	-	4	-	0	-	-	19	-
1995	DOE	169,679	3.22E+08	5,714	3.5	3	2,784	1.7	80,191	49.7
	INEEL	7,094	1.35E+07	237	3.5	0	114	1.7	1,620	24.0
	RWMC	-	-	15	-	0	-	-	22	-
1996	DOE	157,003	2.98E+08	5,195	3.5	2	2,371	1.6	61,568	41.3
	INEEL	6,645	1.26E+07	192	3.0	1	78	1.2	1,100	17.4
	RWMC	-	-	13	-	1	-	-	8	-

a. Rates are per 200,000 hours worked (based on the format of available data).
b. "-" represents no data available.

E-5 FACILITY ACCIDENTS

E-5.1 Introduction

Section E-5 provides background information for Section 5.14, Facility Accidents. A facility accident is an unplanned sequence of events that results in undesirable consequences. This section describes the process used to identify accident scenarios, the basis for evaluating selected scenarios, and the modeling methods and assumptions used to estimate health effects consequences. The analysis of accidents is intended to be conservative in the sense that where uncertainties exist, assumptions that bound the potential for credible consequences are used.

E-5.2 Methodology

E-5.2.1 Selection of Accident Scenarios

Hazard identification and evaluation was performed for the AMWTP to derive the bounding accidents for the facility. The analysis provides a thorough, predominately qualitative, evaluation of the spectrum of risks to the public, workers, and environment. The hazard evaluation ranking qualitatively evaluates the frequency and consequence of an accident using four frequency bins and four consequence bins as described in Table E-5.2-1. The risk associated with each accident is the product of frequency and consequence.

The selection of the risk dominant accident scenarios relies on previous safety analysis reports for the RWMC (EG&G 1986, INEEL 1997) and on the draft preliminary safety analysis report for the AMWTP (BNFL 1998d). In general, the approach is to select the scenarios with the highest consequence within each frequency category. One first examines the scenarios that have a frequency category of anticipated. All of the scenarios in this category have a low consequence with the exception of one scenario which has a moderate consequence. Because of its high frequency, the scenario is a significant contributor to risk even though there are higher consequence events that have lower frequencies. The next step is to examine the scenarios that have a frequency category of unlikely. Four scenarios were identified with a moderate to high consequence within this frequency category. The final step is to examine the extremely unlikely frequency category for scenarios that could have a consequence higher than the consequences of the four unlikely scenarios already selected. Two scenarios were identified that could have higher consequences. The list of potentially risk-dominant design basis accident scenarios for the AMWTP is presented in Table E-5.2-2. The following subsections describe the design basis accident scenarios in more detail.

E-5.2.1.1 Fire Involving Waste in the Box/Drum Line. Transuranic (TRU) waste is removed from containers and sorted for further treatment in the AMWTP facility box and drum lines. It is postulated that a fire could be initiated in uncontained waste within the box or drum line confinement cell. A fire could be initiated by sparking from remote power tools used in the cell to open containers, or from within the waste itself via spontaneous combustion or undetected pyrophoric constituents. The fire then spreads to involve half of the uncontained waste within the cell before the fire is suppressed by fire protection systems. Waste in any unopened containers within the cell is not involved.

Table E-5.2-1. Frequencies and consequences of hazards evaluated.

Frequency	Description	Consequence	Description
Anticipated (>1.0E-02/yr)	Incidents that may occur several times during the lifetime of the facility	None	Negligible onsite and offsite impacts on people or the environment
Unlikely (1.0E-04/yr to 1.0E-02/yr)	Accidents not anticipated to occur during the lifetime of the facility	Low	Minor onsite and negligible offsite impacts on people or the environment
Extremely unlikely (1.0E-6/yr to 1.0E-02/yr)	Accidents that probably do not occur during the life cycle of the facility.	Moderate	Considerable onsite impact on people or the environment: only minor offsite impact
Beyond extremely unlikely (<1.0E-06/yr)	All other accidents	High	Considerable onsite and offsite impacts on people or the environment.

Source: INEEL 1997.

The box and drum lines are Zone 3 confinement cells with ventilation that is part of the AMWTP facility cascade system. The fire is postulated to increase the temperature in the cell and cause increased particulate loading on the ventilation system HEPA filters. The pressure in the cell increases, resulting in a release of radioactivity to Zone 2 areas. Radiation alarm systems and fire suppression systems function as designed, and workers evacuate the building within 5 minutes. No release outside the facility occurs.

Table E-5.2-2. Design basis accident scenarios for the AMWTP.

Accident description	Frequency	Consequence
Fire involving uncontained waste in the proposed AMWTP box and drum line confinement cell	A	L
Loss of pressure differential between confinement zones due to loss of electrical power and backup diesel generator failure	A	L
Waste box dropped outdoors and breaks open during transfer between facilities within the TSA	A	M
Fire involving TRU waste containers within the TSA Retrieval Enclosure	U	M
Incinerator explosion and confinement cell breach caused by a flameout, buildup of excess volatiles and or propane, and subsequent ignition and explosion	U	H
Wind-borne missile breach of building structure which causes a waste box to break open	U	M
Fire involving waste transfer vehicle during transfer between facilities within the TSA	U	H
Vitrifier explosion and confinement cell breach due to severe water incursion and subsequent steam explosion	E	H
Fire in Type II storage module caused by either a range fire, a propane delivery truck accident, or an internal fire that is not detected or suppressed	E	H

Source: BNFL 1998d.

E-5.2.1.2 Loss of All AC Power. It is postulated that a loss of electrical power occurs and the backup diesel generator fails to start or fails to run. Initial efforts to start the emergency generator fail resulting in a complete loss of AC for 10 minutes. During this time the pressure differential between the various confinement zones is not maintained, resulting in the spread of contamination.

Interruptions of offsite power occur up to several times per year at the RWMC, but the duration is usually less than a few minutes. Based on industry statistics for backup diesel generators, the combined likelihood of failure to start, pick up the electrical load, and continue to run is about 0.01 failures per demand. Given several demands per year, the frequency of the postulated accident is in the low end of the anticipated category.

E-5.2.1.3 Dropped Waste Box Outdoors During Transfer. TRU waste in waste boxes is transferred by flatbed truck within the TSA. For each box retrieved from the TSA Retrieval Enclosure (TSA RE), transfers between facilities occur as follows:

1. From TSA RE to Type I module
2. From Type I module to Type II module
3. From Type II module to proposed AMWTP facility.

Each transfer includes loading/unloading, some of which occurs outdoors. It is postulated that a waste box could either be dropped during loading/unloading or fall off a truck during transfer. The dropped waste box breaks open, releasing radioactive and toxic materials to the atmosphere.

E-5.2.1.4 Fire in TRU Waste in the TSA RE. Since 1970, TRU waste has been stored in containers on ground-level asphalt pads within the RWMC TSA. Waste containers were stacked and covered with plywood cover, fabric, and 3 to 4 feet of soil (TSA RE pad is covered with fabric only). It is expected that some containers have deteriorated during storage, and that waste will occasionally be exposed during retrieval operations. It is postulated that exposed waste could be ignited by chemical reaction, electrical discharge, spontaneous combustion, or ignition of pyrophoric materials. Spread of the fire would be limited by container integrity and lack of combustible fuel. A worst-case material at risk is estimated to be five boxes (one container in which the fire is initiated, and four adjacent containers beside and above it).

E-5.2.1.5 Incinerator Explosion. Feed to the incineration process is inorganic homogenous debris, organic homogenous debris, and soil. The postulated accident involves a flameout in the incinerator, buildup of excess volatiles and/or propane in the system, and subsequent ignition and explosion.

The explosion causes breach of the incinerator, the Zone 2 confinement cell, and the roof and/or adjacent maintenance dock access door. The material at risk involves the contents of the incinerator.

E-5.2.1.6 Wind-Borne Missile Breach of Building Structure. TRU waste in drums and waste boxes is received and staged for treatment in the southwest corner of the proposed AMWTP facility. It is postulated that a missile such as a pipe or piece of lumber driven by high wind penetrates the wall of the AMWTP facility and breaks open a waste box.

E-5.2.1.7 Fire Involving Waste Transfer Vehicle. TRU waste is transferred by flatbed semi-truck trailer within the TSA. For each box retrieved from the TSA RE, transfers between facilities occur as follows:

1. From TSA RE to Type I module
2. From Type I module to Type II module
3. From Type II module to proposed AMWTP facility.

The trailers are 40 feet long and can transport a maximum of ten 4 x 4 x 7 foot waste boxes. During a waste transfer, a vehicle accident is postulated to occur due to mechanical failure or human error. The accident initiates a fire that spreads to involve the waste contents of the truck. Fire protection programs and equipment at the AMWTP are assumed to function as planned.

E-5.2.1.8 Vitrifier Explosion. Feed to the vitrification process is ash material from the incinerator system, particulate from the atmospheric protection system, and certain secondary waste. Glass forming additives are continuously fed with the waste to enhance the glass quality of the final waste product drums. Waste and glass feed to the vitrifier is not flammable or explosive. The postulated accident involves a significant water incursion to the vitrifier and subsequent steam explosion. Water incursion could occur due to a severe breach of the vitrifier cooling water jacket, or by initiation of the fire suppression system and accidental flow down a feed, offgas, or bubbler path into the vitrifier chamber.

The explosion causes breach of the vitrifier, the Zone 2 confinement cell, and the roof and/or adjacent building doors. The material at risk involves the glass and “cold cap” in the vitrifier.

E-5.2.1.9 Type II Storage Module Fire. TRU waste is stored in boxes and drums in the seven Type II modules. It is postulated that a worst-case fire could involve a significant fraction of the contents of one Type II module. A worst-case fire could be initiated by a range fire for which control efforts are unsuccessful, and that spreads into the TSA. Other potential initiators are an accident involving a propane delivery truck near a Type II module, or an internal fire that is not detected or suppressed by the fire protection systems.

E-5.2.2 Computer Modeling to Estimate Radiation Doses

Radiological consequences to downwind receptors (collocated workers and public) were estimated using the Radiological Safety Analysis Computer Program (RSAC-5) (Wenzel 1993). The RSAC-5 computer program was developed for the DOE Idaho Operations Office by Westinghouse Idaho Nuclear Co., Inc. and is in the public domain.

RSAC-5 simulates potential radiation doses to maximally exposed individuals or population groups from accidental airborne releases of radionuclides to the environment. From a specified source term, users can calculate the environmental transfer, uptake, and human exposure. Individual doses are determined at specific distances onsite, at the site boundaries, and away from the site via airborne plume immersion, ground surface contamination, inhalation, and ingestion. The ingestion pathway applies only where food is raised locally and potentially consumed there.

The RSAC-5 program uses a two-dimensional Gaussian atmospheric-dispersion model to estimate the dispersion of the radioactive-material plume at various distances downwind from the point of release. INEEL-specific values of these dispersion coefficients are built into RSAC-5 for calculation of dispersion factors (÷/Qs). The meteorological capabilities of RSAC-5 include Pasquill-Gifford, Hilsmeier-Gifford, and Markee models for Gaussian plume diffusion.

RSAC-5 uses weighting factors for various body organs to calculate a committed effective dose equivalent (CEDE) from radioactivity deposited inside the body by inhalation or ingestion. RSAC-5 calculates an effective dose equivalent (EDE) for the external exposure pathways (immersion in plume, exposure from ground surface contamination) and a 50-year CEDE for the internal exposure pathways (inhalation, ingestion). The sum of the EDE from external pathways and the CEDE from internal pathways is called the total effective dose equivalent (TEDE).

E-5.2.3 Modeling for Hazardous Chemical Releases

The determination of hazardous chemical exposures for various accident scenarios uses the same release times and dispersion coefficients (÷/Qs) as those used for the radiological consequences. The toxicological evaluation guidelines are in terms of air concentration in units of mg/m^3. Because Emergency Response Planning Guidelines do not exist for the hazardous chemical constituents of the retrievable stored waste at RWMC to be processed at the AMWTP, the most restrictive criterion is used based on the following:

- For TOX-1,
  - Permissible exposure limit-time-weighted average (PEL-TWA)
  - Threshold limit value-time-weighted average (TLV-TWA).

- For TOX-2,
  - Emergency exposure guidance level (EEGL) (60 min)
  - 10 percent of immediately dangerous to life or health (IDLH).

For anticipated events, the offsite consequences should be less than the PEL-TWA or the TLV-TWA, whichever is more restrictive. TOX-1 is the applicable evaluation guideline for unlikely events and TOX-2 is applied for extremely unlikely events.

Table E-5.2-3 shows the basic toxicological criteria used in the derivation of the toxicological evaluation guidelines. The TLVs have been defined to include various levels of exposure to worker populations. TLVs are published by the ACGIH. The population that comprises the general public differs from the population defined for TLVs in that the general public includes additional groups such as children, elderly persons, and hospitalized patients. The two thresholds used here are:

- TLV-TWA: The threshold limit value-time-weighted average for a specific substance defines the limit of acceptable concentration to which most workers can be exposed for up to a normal 8-hr day and a 40-hr week without adverse effect.

- TLV-STEL: The threshold limit value-short term exposure limit is a TWA concentration to which workers should not be exposed for longer than 15 minutes and which should not be repeated more than four times per day, with at least 60 minutes between successive exposures. Whereas the TLV-TWA is useful for chronic exposure effects, the TLV-STEL addresses acute effects of short-term, high-level exposures.

The PELs have been developed by the OSHA as a measure for safe and healthful working conditions for men and women employed in any business engaged in commerce in the United States. As with other exposure limits developed for industrial applications, limitations exist with respect to applicability to the general population.

The IDLH levels have been developed to define concentrations of materials from which workers should evacuate within 30 minutes without escape-impairing symptoms or any irreversible health effect. As IDLH values were developed by the National Institute for Occupational Safety and Health for industrial application, their usefulness for application to the general population is limited.

An EEGL is a concentration of a substance in air judged by the Department of Defense to be acceptable for the performance of specific tasks by military personnel during emergency conditions lasting 1 to 24 hours. EEGL dosages may produce transient central nervous system effects and eye or respiratory irritation, but none serious enough to prevent response to emergency conditions.

Table E-5.2-3. Basic toxicological criteria for derivation of TOX-1 and TOX-2.

Substance	ACGIH TLVs TWA (mg/m^3)	ACGIH TLVs STEL/C (mg/m^3)	OSHA PELs TWA (mg/m^3)	OSHA PELs STEL/C (mg/m^3)	IDLH (mg/m^3)	EEGL (mg/m^3)
Solids						
Asbestos[a]	2 f/cc	—	0.1 f/cc	1 f/cc (30 min)	—	—
Beryllium	0.002	0.006[b]	0.002	C0.005	4	—
Cadmium	0.002	0.006[b]	0.005	—	9	—
Lead	0.15	0.45[b]	0.05	—	100	—
Lithium chromate[c]	0.05	0.15	—	C0.1	15	15
Nitrates[d]	—	—	—	—	—	—
Liquids						
n-Butyl alcohol	—	C152	300	—	4,236	—
Carbon tetrachloride	31	63	63	C158	1,258	—
Mercury	0.05	0.15[b]	0.05	C0.1	10	0.2 (24 hr)
Methyl alcohol	262	328	260	310	7,861	262
Methylene chloride	174	522[b]	1,740	C3,480	7,970	—
Nitric acid	5.2	10	5	10	64	—
Polychlorinated byphenyls	0.5	1.5[b]	0.5	—	5	—
Perchloroethylene	170	678	685	C1,370	1,015	—
1,1,1-trichloroethane	1,910	2,460	1,900	2,450	3,811	—
1,1,2-trichloro-1,2,2-trifluoroethane	7,670	9,590	7,600	9,500	15,298	11,505
Trichloroethylene	269	537	540	C1,080	5,363	—
Xylene	434	651	435	655	3,901	868

Source: INEEL 1997.

[a.] The density of chrysotile is 1.55 gm/cc (1.55E+09 mg/m^3). Fibers of respirable size would be approximately 10 microns long and 3.3 microns in diameter with a mass of 1.3E-07 mg per fiber. Using the concentration is mg/m^3 at each receptor and converting to fibers/cc allows a comparison of the asbestos released to the appropriate TLV or PEL.

[b.] No STEL/C is established for these substances. Values listed are 3× the specific TWA values, as specified by DOE Standard 3005.

[c.] For purposes of establishing toxicological limits, chromium is used.

[d.] Nitrates are primarily sodium or potassium nitrates. There are no toxicological limits for these compounds.

E-5.3 Inventory of Radioactive and Hazardous Materials

The retrievably stored TRU waste at the RWMC is in the TSA. The source of information for the inventories in this area is the Radioactive Waste Management Information System. It is the official INEEL record for stored solid radioactive waste (TRU and mixed waste), disposed low-level waste , and processed waste (TRU, low-level waste, and mixed). The inventory in the TSA is what the AMWTP facility will treat prior to offsite shipment and disposal.

The TSA was established in November 1970 as a storage area for retrievable waste contaminated with greater than 10 nCi/g of TRU activity. The definition of TRU waste was finalized in 1982 to read "greater than 100 nCi/g," in accordance with DOE Order 5820.2. Contact-handled (CH) TRU waste is stored aboveground on asphalt pads designated TSA-1, -2, -3, and -R. The waste currently stored on these pads is being transferred to RCRA-approved temporary storage in the Waste Storage Facilities (WSFs) Type I and Type II storage modules. Remote-handled (RH) TRU waste is stored in the Intermediate-Level Transuranic Storage Facility (ILTSF), established in 1976. This waste is stored above grade and is designated as retrievably stored. The ILTSF comprises two pads containing storage vaults.

The volume and curie inventory are presented in Table E-5.3-1. CH TRU waste is the major inventory class of radionuclides within the TSA. The volume of CH TRU waste is approximately 65,000 cubic meters. This volume of waste is stored in approximately 140,000 waste containers. The volume of RH TRU waste stored at the ILTSF is approximately 77 m^3. The ILTSF waste is contained in approximately 619 waste containers. The ILTSF waste is also contaminated with TRU nuclides. However, the ILTSF waste is primarily composed of beta/gamma-emitters. The decay-corrected activity of the ILTSF waste is approximately 11.0 Ci/m^3. The dominant radionuclides found in the TSA waste are Pu-241, Pu-238, Pu-239, and Am-241. The average decay-corrected activity of TSA waste is approximately 5.65 Ci/m^3. The concentration of radionuclides typically present in TSA waste is presented in Table E-5.3-2. Table E-5.3-3 is the inventory of radionuclides in the 65,000m^3 of TSA waste (including a correction to account for the additional 20,000m^3 to be treated at the AMWTP facility) and the calculated partitioning of radionuclides between the two primary waste streams, non-debris and debris. The breakdown of the various container types for waste stored at the TSA is presented in Table E-5.3-4.

The hazardous chemicals inventory found in the retrievably stored waste at the TSA is provided in Table E-5.3-5. These hazardous chemical quantities are derived primarily from the waste generator and process knowledge of the incoming waste. The hazardous source term was developed with a conservative philosophy. Therefore, the weight fractions of hazardous substances actually present in the stored waste are judged to be lower than estimated. The release of hazardous substances, regulated pollutants, or oil not permitted by Federal regulations requires that the occurrence be reported. Reportable quantities are listed in 40 CFR Part 302, Table 302.4. Hazardous substances and materials released in quantities greater than the reportable quantities are subject to reporting to the National Response Center as required by DOE Order 232.1-1. Sodium chromate, hydrochloric acid, nitrobenzene, and ether appear in the source documents of incoming wastes, and, if present at all, they are present in only trace amounts.

Table E-5.3-1. Volume and decayed activity in waste stored at the TSA.

Location[a]	Volume (m^3)	2/17/93 Activity[b] (Ci)
TSA		
TRU		200,500
Non-TRU		
Total	64,691.2	
ILTSF		
TRU		100.3
Non-TRU		8,388
Total	77.2	8,489

Source: INEEL 1997.
a. In this table, the designation TSA means all of the Transuranic Storage Area except the ILTSF.
b. The activities are rounded off to four significant digits.

Table E-5.3-2. General concentration distribution of waste in the TSA.

	Concentration	
Radionuclide distribution	(Ci/m^3)	(Ci/ft^3)
44.3% Pu-241	2.5E+00	7.1E-02
24.3% Am-241	1.4E+00	3.9E-02
16.8% Pu-238	9.7E-01	2.7E-02
11.3% Pu-239	6.3E-01	1.8E-02
2.7% Pu-240	1.5E-01	4.3E-03
0.2% U-233	1.4E-02	3.9E-04
0.2% Cm-244	0.8E-02	2.4E-04

Source: INEEL 1997.

Table E-5.3-3. Radionuclide Inventory for TSA Waste and Scaled for the AMWTP facility.

Radionuclide[a]	Best Estimate Activity[b] (Ci)	Scaled Best Estimate Activity[c] (Ci)	Scaled Activity Non-Debris[d] (Ci)	Scaled Activity Debris[e] (Ci)	Activity Concentra'n Non-Debris[f] (Ci/kg)	Activity Concentra'n Debris[g] (Ci/kg)
Am-241	1.22E+05	1.60E+05	7.02E+04	8.93E+04	4.40E-03	4.49E-03
Pu-238	1.16E+05	1.52E+05	6.67E+04	8.49E+04	4.19E-03	4.27E-03
Pu-239	6.87E+04	8.98E+04	3.95E+04	5.03E+04	2.48E-03	2.53E-03
Pu-240	1.59E+04	2.08E+04	9.15E+03	1.16E+04	5.74E-04	5.86E-04
Pu-242	1.04E+00	1.36E+00	5.98E-01	7.62E-01	3.75E-08	3.83E-08
Pu-241	1.61E+05	2.11E+05	9.26E+04	1.18E+05	5.81E-03	5.93E-03
Ba-137m	2.25E+03	2.94E+03	1.29E+03	1.65E+03	8.12E-05	8.29E-05
Cs-137	2.26E+03	2.96E+03	1.30E+03	1.66E+03	8.16E-05	8.33E-05
Sr-90	2.02E+03	2.64E+03	1.16E+03	1.48E+03	7.29E-05	7.44E-05
Y-90	2.02E+03	2.64E+03	1.16E+03	1.48E+03	7.29E-05	7.44E-05
U-233	1.02E+03	1.33E+03	5.87E+02	7.47E+02	3.68E-05	3.76E-05
Cm-244	5.39E+02	7.05E+02	3.10E+02	3.95E+02	1.95E-05	1.99E-05
H-3	2.64E+02	3.45E+02	1.52E+02	1.93E+02	9.53E-06	9.72E-06
Cs-134	1.11E+02	1.45E+02	6.39E+01	8.13E+01	4.01E-06	4.09E-06
Co-60	1.00E+02	1.31E+02	5.75E+01	7.32E+01	3.61E-06	3.68E-06
Total (primary)	4.94E+05	6.46E+05				
Minor Radionuclides (present in TSA waste at between 1 and 100 Ci)						
Bi-212	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
C-14	2.38E+00	3.11E+00	1.37E+00	1.74E+00	8.59E-08	8.77E-08
Ce-144	2.71E+01	3.54E+01	1.56E+01	1.98E+01	9.78E-07	9.98E-07
Fe-55	1.13E+00	1.48E+00	6.50E-01	8.28E-01	4.08E-08	4.16E-08
Kr-85	6.86E+00	8.97E+00	3.95E+00	5.02E+00	2.48E-07	2.53E-07
Ni-63	3.57E+00	4.67E+00	2.05E+00	2.61E+00	1.29E-07	1.32E-07
Pb-212	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Pm-147	2.73E+01	3.57E+01	1.57E+01	2.00E+01	9.86E-07	1.01E-06
Po-212	1.70E+01	2.22E+01	9.78E+00	1.24E+01	6.14E-07	6.26E-07
Po-216	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Pr-144	2.72E+01	3.56E+01	1.57E+01	1.99E+01	9.82E-07	1.00E-06
Ra-224	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Sb-125	1.65E+00	2.16E+00	9.49E-01	1.21E+00	5.96E-08	6.08E-08
Th-228	2.66E+01	3.48E+01	1.53E+01	1.95E+01	9.60E-07	9.80E-07
Th-232	7.31E+00	9.56E+00	4.21E+00	5.35E+00	2.64E-07	2.69E-07
Tl-208	9.54E+00	1.25E+01	5.49E+00	6.99E+00	3.44E-07	3.51E-07
U-232	2.60E+01	3.40E+01	1.50E+01	1.90E+01	9.39E-07	9.58E-07
U-234	5.78E+00	7.56E+00	3.33E+00	4.23E+00	2.09E-07	2.13E-07
Total (minor)	2.96E+02	3.87E+02				

a. Radionuclides from Table 4-1 INEL-95/0412, Radon (Rn-220) not included per 40 CFR 61, Subpart H.
b. Best estimate activities from Table 4-1 INEL-95/0412.
c. Scaling factor is 85,000 m3 / 65,000 m^3.
d. Non-Debris mass is 44.49% (44%) of total waste mass.
e. Debris mass is 55.51% (56%) of total waste mass.
f. Based on Total Non-Debris Mass of 15,936,396 kg (Process flow sheet node 23).
g. Based on Total Debris Mass of 19,879,854 kg (Process flow sheet nodes 24, 25, 26 and 4D).

Table E-5.3-4. Breakdown of TSA waste by container type.

Container type	Number
Bin	550
BLM[a]	127,690
BXC[b]	1
BXW[c]	8,800
BXM[d]	2,356
O[e]	27
Total Container	139,424

Source: INEEL 1997.
a. BLM: Metal barrel (drum).
b. BXC: Cardboard box.
c. BXW: Wooden box (fiberglass reinforced polyester and plywood).
d. BXM: Metal box.
e. O: Other

It is possible that because of previous use, mixing, contamination, and long-term radioactive effects, certain radioactive mixed waste may become more hazardous. Furthermore, other hazardous substances could conceivably be created by the addition of thermal energy and chemical recombinations. The number of substances created and the extent to which they are created are a function of numerous variables (e.g., oxygen availability, temperature, composition of the involved wastes).

Several articles have appeared in technical journals regarding the products from thermal stressing of chlorinated organics. These articles support the fact that halogenated hydrocarbons in the TSA wastes can form dangerous decomposition products such as phosgene ($COCl_2$), chlorine gas (Cl_2), hydrochloric acid (HCl), carbon dioxide (CO_2), and carbon monoxide (CO). However, the formation of these products requires high temperatures not normally present. Under oxygen-rich conditions, essentially all chlorinated organics from elemental Cl_2, with no HCl or phosgene production. Conversely, for oxygen-lean reactions, HCl is the favored product with possibly a small amount of phosgene. Under no conditions is phosgene a favored end product. It only occurs as a trace material under oxygen-lean conditions. As temperatures are increased, phosgene decomposes to HCl or Cl_2. At very high temperatures (e.g., >1900°C), all the chlorine compounds begin to decompose and form ionized species such as Cl^- and/or H^+.

Table E-5.3-5. Hazardous chemical inventory for waste stored at the TSA.

Chemical	Average weight fraction of stored waste	Maximum weight fraction of any waste container	Estimated stored waste quantity (kg)	Reportable quantity (kg)
Asbestos	2.74E-03	4.5E-01	71,328	0.454
Barium[a]	0.0	0.0	0.0	None
Beryllium	2.1E-04	9.5E-01	5392	4.54
Cadmium	3.0E-06	1.0E-05	78	4.54
Carbon tetrachloride	6.27E-03	5.0E-02	163,255	4.54
Chromium[a]	0.0	0.0	0.0	2270
n-Butyl alcohol	3.0E-06	1.0E-05	81	2270
Ether[a]	0.0	0.0	0.0	—
Lead	8.26E-03	6.0E-01	215,180	0.454
Hydrochloric acid[a]	0.0	0.0	0.0	2270
Lithium chromate	1.77E-03	2.0E-01	46,032	4.54
Mercury	3.54E-03	2.0E-01	92,211	0.454
Methyl alcohol	8.0E-06	2.5E-05	200	2270
Methylene chloride	4.0E-04	1.0E-03	10,298	454
Nitric acid	1.9E-03	5.05E-01	49,502	454
Nitrates[b]	3.7E-03	9.0E-01	9,655	(c)
Nitrobenzene[a]	0.0	0.0	0.0	454
PCB	8.54E-03	5.56E-01	222,472	0.454
Selenium[a]	0.0	0.0	0.0	45.4
Silver[a]	0.0	0.0	0.0	454
Perchloroethylene	6.2E-04	5.0E-02	16,275	45.4
Sodium chromate[a]	0.0	0.0	0.0	4.54
1,1,1-trichloroethane	5.81E-03	1.5E-01	151,434	454
Trichloroethylene	3.92E-03	1.5E-01	102,097	45.4
1,1,2-trichloro-1,2,2-trifluoroethane	3.71E-03	5.0E-02	96,677	—
Xylene	2.0E-05	5.0E-05	399	454

Source: INEEL 1997.
a. Any 0.0 entry indicates that trace quantities may exist.
b. Nitrates are classified as evaporator salts comprised of sodium nitrate and potassium nitrate.

Analysis of the reactions necessary to produce phosgene from PCBs reveals that such production is extremely unlikely because of the stable nature of the PCB benzene ring and the sequential steps necessary. Production of free chlorine is also unlikely. Likewise, production of phosgene from freons is extremely unlikely because of the strength of the carbon-fluorine bond and the sequential steps necessary. An unlikely end product would be carbonyl fluoride which immediately hydrolyses in the presence of moisture to form carbon dioxide and hydrofluoric acid.

The substance of greatest concern is methylene chloride. Radiolytic action in methylene chloride can produce phosgene by sequential steps. This reaction can occur at quite low energy levels and can be caused by drums heating in sunlight, as well as by ultraviolet radiation from the sun. In the presence of moisture, however, the phosgene hydrolyses over time to form hydrochloric acid and carbon dioxide. Radiolytic action can occur only where relatively high specific radioactivity exists.

Based on the absence of high processing temperatures and the stable nature of the waste materials, it is considered unlikely that sufficient hazardous substances could be created through chemical recombinations to cause injury to the worker or the public.

During accident scenarios involving fires and explosions, phosgene and hydrochloric acid are potential combustion products of chlorinated hydrocarbons and therefore they are accounted for in the accident source terms.

E-5.4 Accident Consequence Assessment

E-5.4.1 Source Terms

To calculate the downwind consequences, a source term (ST) was determined. The ST is the amount of radioactive material released during a specific accident scenario. The STs for each accident scenario are determined using the following equation:

$$BST = MAR \times DR \times ARF \times RF \times LPF$$

where

ST	=	source term (g)
MAR	=	material at risk (g)
DR	=	damage ratio
ARF	=	airborne release fraction
RF	=	respirable fraction
LPF	=	leak path fraction.

Material at Risk. The material at risk (MAR) is the total waste inventory impacted for a given accident scenario and is expressed in terms of total mass at risk (g).

Damage Ratio. The DR represents the fraction of the MAR that could be affected by the postulated accident and is a function of the accident initiator and the operational event being evaluated. The DRs are presented in two ways: a percentage of the total inventory or a finite portion of the total inventory. Percentage of the total inventory is used for accident scenarios such as earthquakes or fires. A finite portion of the total inventory is used for operational accidents in which the actual number of drums or boxes is known.

Airborne Release Fraction. The ARF is that fraction of total radioactive or hazardous chemical material used in a process or contained in storage that is assumed released from its primary confinement in a dispersible form by a postulated accident.

Leak Path Fraction. The LPF is that fraction of total radioactive or hazardous chemical material released from its primary confinement that is assumed released from its secondary confinement in a dispersible form by a postulated accident.

Respirable Fraction. The RF represents the fraction of the material with an aerodynamic equivalent diameter less than 10 μm. RF on particles made airborne under accident conditions are correlated to the stresses induced. Estimates for RF for mechanical releases range from 1.0 to 1.0E-03 based on the amount, type, and dispersability of the powder present.

E-5.4.1.1 Fire Involving Waste in the Box/Drum Line. The inventory of uncontained waste is limited by the mass of fissile material. A maximum of 450 grams of Pu-239 equivalent may be uncontained and in process within the cell at any time. The MAR is shown in Table E-5-8. The MAR assumes 450 g Pu-239 equivalent, and that all transuranic nuclides are present at the ratio of the average concentration in TRU waste at the TSA. Non-TRU nuclides are assumed to be present in the waste at a proportional quantity. The toxic chemical MAR is assumed to be the equivalent of two boxes of TRU waste.

It is assumed that uncontained waste would be located in various areas within the process cell, and some waste would be in export drums on the first floor and less available to the fire. Also, spread of the fire would be controlled by fire protection systems. The damage ratio is estimated to be 0.5.

TRU waste is assumed to be 35 percent combustible and 65 percent noncombustible. The ARF for a fire in combustible uncontained, surface-contaminated waste is 0.01 per DOE-HDBK-3010-94, Section 5.2.1.4. The ARF for a fire in noncombustible surface contaminated waste is 6.0E-3 per DOE-HDBK-3010-94, Section 5.3.1. The ARF for toxic chemicals is 0.01 for solids, 0.1 for semivolatile liquids, and 1.0 for volatile liquids.

When exposed to heat and flame, all halogenated compounds can be broken down to produce halogenated acids and small quantities of phosgene-type compounds. It is assumed that 89 percent of chlorinated hydrocarbons are volatilized, 10 percent decomposes to hydrochloric acid, and 1 percent are converted to phosgene gas. The phosgene molecular conversion ratio for chlorinated hydrocarbons is approximately 1.19. Therefore, the airborne release fraction for phosgene is 0.0119.

The RF for a fire in combustible uncontained, surface-contaminated waste is 1.0 per DOE-HDBK-3010-94, Section 5.2.1.4. The RF for a fire in noncombustible surface-contaminated waste is 0.01 per DOE-HDBK-3010-94, Section 5.3.1. The RF for toxic chemicals is 1.0.

The combined radionuclide ARF and RF for the accident includes the combustible and noncombustible fractions as follows:

ARF x RF = 0.35 (0.01 x 1) + 0.65 (6.0E-03 x 0.01) = 3.54E-03.

The fire is assumed to heat up the atmosphere in the cell by 100^{o}F, consequently increasing the volume of the air in the cell by 20 percent. The 20 percent of the cell volume is released to an occupied Zone 2 area over a 1-hour period. The initial concentration in the Zone 2 area is 0, and a worker evacuates in 5 minutes. The effective leak path factor is 8.33E-03. The source terms for Zone 2 are presented in Table E-5.4-1.

Table E-5.4-1. Source term for fire involving waste in the box/drum line.

Nuclide/chemical	MAR (g)	DR	ARF x RF	LPF	Source (g)
Pu-241	1.30E+00	0.5	3.54E-03	8.33E-03	1.91E-05
Am-241	2.46E-01	0.5	3.54E-03	8.33E-03	3.63E-06
Pu-238	2.82E-01	0.5	3.54E-03	8.33E-03	4.16E-06
Pu-239	4.09E+02	0.5	3.54E-03	8.33E-03	6.02E-03
Pu-240	5.82E-01	0.5	3.54E-03	8.33E-03	8.57E-06
U-233	3.90E+01	0.5	3.54E-03	8.33E-03	5.75E-04
Cm-244	2.21E-04	0.5	3.54E-03	8.33E-03	3.26E-09
Cs-134	3.17E-05	0.5	3.54E-03	8.33E-03	4.67E-10
Cs-137	9.59E-03	0.5	3.54E-03	8.33E-03	1.41E-07
Ba-137m	1.57E-09	0.5	3.54E-03	8.33E-03	2.31E-14
Sr-90	5.45E-03	0.5	3.54E-03	8.33E-03	8.03E-08
Y-90	1.38E-06	0.5	3.54E-03	8.33E-03	2.04E-11
Co-60	3.22E-05	0.5	3.54E-03	8.33E-03	4.74E-10
H-3	4.19E-07	0.5	3.54E-03	8.33E-03	6.18E-12
Asbestos	7.03E+03	0.5	3.50E-03	8.33E-03	1.03E-01
Beryllium	5.32E+02	0.5	3.50E-03	8.33E-03	7.75E-02
Cadmium	7.69E+00	0.5	3.50E-03	8.33E-03	1.12E-04
Carbon tetrachloride	1.61E+04	0.5	3.50E-01	8.33E-03	2.35E+01
n-Butyl alcohol	7.99E+00	0.5	3.50E-01	8.33E-03	1.16E-02
Lead	2.12E+04	0.5	3.50E-03	8.33E-03	3.09E-01
Lithium chromate	4.54E+03	0.5	3.50E-03	8.33E-03	6.62E-02
Mercury	4.04E+02	0.5	3.50E-01	8.33E-03	5.89E-01
Methyl alcohol	1.97E+01	0.5	3.50E-01	8.33E-03	2.87E-02
Methylene chloride	1.02E+03	0.5	3.50E-01	8.33E-03	1.48E+00
Nitric acid	4.88E+03	0.5	3.50E-02	8.33E-03	7.11E-01
Nitrates	9.52E+02	0.5	3.50E-02	8.33E-03	1.39E-01
PCB	9.70E+02	0.04	3.50E-02	8.33E-03	1.13E-02
Perchloroethylene	1.60E+03	0.5	3.50E-01	8.33E-03	2.34E+00
1,1,1-trichloroethane	1.49E+04	0.5	3.12E-01	8.33E-03	1.94E+01
Trichloroethylene	1.01E+04	0.5	3.12E-01	8.33E-03	1.31E+01
1,1,2-trichloro-1,2,2-trifluoroethane	9.53E+03	0.5	3.12E-01	8.33E-03	1.24E+01
Xylene	3.93E+01	0.5	3.50E-01	8.33E-03	5.73E-02
Phosgene[a]	3.45E+04	0.5	4.17E-03	8.33E-03	5.99E-01
Hydrochloric acid[a]	3.45E+04	0.5	3.50E-02	8.33E-03	5.03E+00

Source: BNFL 1998d.

a. Phosgene and hydrochloric acid are not in the waste inventory, but are a potential combustion product of chlorinated hydrocarbons.

E-5.4.1.2 Loss of All AC Power. The MAR is the airborne contamination throughout the AMWTP facility. The highest concentrations of airborne contaminants are assumed to be in the following Zone 3 areas:

- Box line
- Drum line
- Incinerator hoppers and shredder
- Vitrifier hoppers
- Supercompactor glovebox.

It is assumed that each area has the airborne equivalent of one waste box being dumped out. The total MAR is therefore the nuclide-specific concentration in average TRU waste, times the volume of a waste box, times an airborne release fraction of 1.0E-03 per DOE-HDBK-3010-94 Section 5.3.3.2.2, times five areas. The ARF for viscous liquids is 2.0E-05 per DOE-HDBK-3010-94, Section 3.2.3.1.

All contaminants are assumed to be free to migrate following a total loss of electrical power. Therefore, the DR is 1.0. The ARF and RF of the airborne contaminants are also assumed to be 1.0.

Because the AMWTP facility cascade ventilation systems are inoperable, contamination migrates through natural convection. In many areas, migration is prevented or impeded by airlocks at zone boundaries. The extent of the time-dependent migration is indeterminate. For purposes of this assessment, the following assumptions are made to bound the release from the AMWTP facility:

- Ten percent of the Zone 3 contaminants are transferred to Zone 2 upon loss of power.
- Ten percent of the new Zone 2 contaminants are transferred to Zone 1 upon loss of power.
- Ten percent of the new Zone 1 contaminants are released from the building.

The LPF for release from the AMWTP facility is 1.0E-03. The LPF is 0.1 for workers in Zone 2 areas and 0.01 for workers in Zone 1 areas. A worker is exposed for 5 minutes before evacuating. The source terms for the release from the AMWTP facility are presented in Table E-5.4-2.

E-5.4.1.3 Dropped Waste Box Outdoors During Transfer. The volume of waste within a waste box is 3.2 cubic meters. It is assumed that all radionuclides and toxic constituents are present at the average concentration in TRU waste at the TSA.

It is assumed that the box breaks open and all waste is available to be released. Therefore, a DR of 1.0 is assumed. The ARF for a free-fall spill and impact stress of surface-contaminated waste is 1.0E-03 per DOE-HDBK-3010-94, Section 5.3.3.2.2. The ARF for viscous liquids (mercury and PCB) is 2.0E-05 per DOE-HDBK-3010-94, Section 3.2.3.1. The bounding RF for a free-fall spill and impact stress of surface-contaminated waste is 1.0 per DOE-HDBK-3010-94, Section 5.3.3.2.2. The accident is assumed to occur outdoors with no confinement. Therefore, the LPF is 1.0. Using these factors, the source term to the environment can be determined as shown in Table E-5.4-3.

Table E-5.4-2. Source Term for Loss of All AC Power.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Pu-241	3.85E-04	1.0	1.00E+00	1.00E-03	3.85E-07
Am-241	8.76E-03	1.0	1.00E+00	1.00E-03	8.76E-06
Pu-238	1.67E-03	1.0	1.00E+00	1.00E-03	1.67E-06
Pu-239	2.73E-01	1.0	1.00E+00	1.00E-03	2.73E-04
Pu-240	1.73E-02	1.0	1.00E+00	1.00E-03	1.73E-05
U-233	2.61E-02	1.0	1.00E+00	1.00E-03	2.61E-05
Cm-244	1.64E-06	1.0	1.00E+00	1.00E-03	1.64E-09
Cs-134	2.11E-08	1.0	1.00E+00	1.00E-03	2.11E-11
Cs-137	6.39E-06	1.0	1.00E+00	1.00E-03	6.39E-09
Ba-137m	1.04E-12	1.0	1.00E+00	1.00E-03	1.04E-15
Sr-90	3.63E-06	1.0	1.00E+00	1.00E-03	3.63E-09
Y-90	9.22E-10	1.0	1.00E+00	1.00E-03	9.22E-13
Co-60	2.18E-08	1.0	1.00E+00	1.00E-03	2.18E-11
H-3	6.70E-09	1.0	1.00E+00	1.00E-03	6.70E-12
Asbestos	1.76E+01	1.0	1.00E+00	1.00E-03	1.76E-02
Beryllium	1.33E+00	1.0	1.00E+00	1.00E-03	1.33E-03
Cadmium	1.92E-02	1.0	1.00E+00	1.00E-03	1.92E-05
Carbon tetrachloride	4.02E+01	1.0	1.00E+00	1.00E-03	4.02E-02
n-Butyl alcohol	2.00E-02	1.0	1.00E+00	1.00E-03	2.00E-05
Lead	5.30E+01	1.0	1.00E+00	1.00E-03	5.30E-02
Lithium chromate	1.13E+01	1.0	1.00E+00	1.00E-03	1.13E-02
Mercury	2.02E-02	1.0	1.00E+00	1.00E-03	2.02E-05
Methyl alcohol	4.93E-02	1.0	1.00E+00	1.00E-03	4.93E-05
Methylene chloride	2.54E+00	1.0	1.00E+00	1.00E-03	2.54E-03
Nitric acid	1.22E+01	1.0	1.00E+00	1.00E-03	1.22E-02
Nitrates	2.38E+00	1.0	1.00E+00	1.00E-03	2.38E-03
PCB	4.85E-02	1.0	1.00E+00	1.00E-03	4.85E-05
Perchloroethylene	4.01E+00	1.0	1.00E+00	1.00E-03	4.01E-03
1,1,1-trichloroethane	3.73E+01	1.0	1.00E+00	1.00E-03	3.73E-02
Trichloroethylene	2.52E+01	1.0	1.00E+00	1.00E-03	2.52E-02
1,1,2-trichloro-1,2,2-trifluoroethane	2.38E+01	1.0	1.00E+00	1.00E-03	2.38E-02
Xylene	9.83E-02	1.0	1.00E+00	1.00E-03	9.83E-05

Source: BNFL 1998d.

E-5.4.1.4 Fire in TRU Waste in the TSA RE. The MAR is the inventory of waste within each of the five waste boxes. It is assumed that all radionuclides are present at the average concentration in TRU waste at the TSA. The MAR is presented in Table E-5.4-4.

Even in this worst-case fire scenario, it is unreasonable to postulate that all exposed containers would be involved in a fire. Results of severe fire tests documented in DOE-HDBK-3010-94, Section 7.3.9.2, indicate that only a fraction of containers would be totally breached, some would be only partially breached (lid seal failure), and some would remain intact. Fire suppression activities would also limit spread of the fire. From this information, a bounding DR of 0.25 is estimated.

TRU waste is assumed to be 35 percent combustible and 65 percent noncombustible. The ARF for a fire in combustible contained, surface-contaminated waste is 5.0E-04 per DOE-HDBK-3010-94, Section 5.2.1.1. The ARF for a fire in noncombustible surface contaminated waste is 6.0E-3 per DOE-HDBK-3010-94, Section 5.3.1. The ARF for toxic chemicals is 0.01 for solids, 0.1 for semivolatile liquids, and 1.0 for volatile liquids.

When exposed to heat and flame, all halogenated compounds can be broken down to produce halogenated acids and small quantities of phosgene-type compounds. It is assumed that 89 percent of chlorinated hydrocarbons are volatilized, 10 percent decomposes to hydrochloric acid, and 1 percent are converted to phosgene gas. The phosgene molecular conversion ratio for chlorinated hydrocarbons is approximately 1.19. Therefore, the airborne release fraction for phosgene is 0.0119.

E-5.4.1.5 Incinerator Explosion. The MAR includes waste in the feed auger, primary chamber, and ash collection drum. Based on preliminary incinerator design, it is estimated that there could be 6 cubic meters of waste in the incinerator system at the time of the explosion. It is assumed that all radionuclides are present at the average concentration of TRU waste at the TSA. Other MAR that could be released in the explosion, such as loading on incinerator offgas system filters, is considered insignificant compared to the incinerator. It is assumed that incomplete combustion has taken place in the waste in the incinerator, and that toxic compounds are present at the average concentration in TRU waste. The MAR is presented in Table E-5.4-5.

An explosion DR of 0.1 is estimated for the material in the incinerator. The ARF for ash is 6.0E-03 and the RF is 0.01 per DOE-HDBK-3010-94, Section 4.4.1.1. The explosion is assumed to cause failure of the incinerator cell and the roof above the incinerator cell and/or the adjacent maintenance door. A LPF of 1.0 is conservatively assumed. Using the above factors, the source term to the environment can be determined as presented in Table E-5.4-5.

E-5.4.1.6 Wind-Borne Missile Breach of Building Structure. The volume of waste within a waste box is 3.2 m^3. It is assumed that all radionuclides and toxic constituents are present at the average concentration in TRU waste at the TSA.

It is assumed that the box breaks open and all waste is available to be released. Therefore, a DR of 1.0 is assumed. The ARF for a free-fall spill and impact stress of surface-contaminated waste is 1.0E-03 per DOE-HDBK-3010-94, Section 5.3.3.2.2. The ARF for viscous liquids (mercury and PCB) is 2.0E-05 per DOE-HDBK-3010-94, Section 3.2.3.1. The bounding RF for a free-fall spill and impact stress of surface-contaminated waste is 1.0 per DOE-HDBK-3010-94, Section 5.3.3.2.2. The accident occurs within the breached confinement. Cascade ventilation is assumed to continue functioning during the accident, although extreme winds could also disrupt offsite power and require starting of backup systems. Ventilation is made less efficient by the breached room and the wind. It is estimated that a maximum of 10 percent of the material made airborne due to the impact of the missile could be released to the environment. Using these factors, the source term to the environment can be determined as shown in Table E-5.4-6.

Table E-5.4-3. Source Term for Dropped Waste Box Outdoor During Transfer.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Pu-241	7.71E-02	1.0	1.00E-03	1.0	7.71E-05
Am-241	1.75E+00	1.0	1.00E-03	1.0	1.75E-03
Pu-238	3.34E-01	1.0	1.00E-03	1.0	3.34E-04
Pu-239	5.46E+01	1.0	1.00E-03	1.0	5.46E-02
Pu-240	3.46E+00	1.0	1.00E-03	1.0	3.46E-03
U-233	5.22E+00	1.0	1.00E-03	1.0	5.22E-03
Cm-244	3.28E-04	1.0	1.00E-03	1.0	3.28E-07
Cs-134	4.22E-06	1.0	1.00E-03	1.0	4.22E-09
Cs-137	1.28E-03	1.0	1.00E-03	1.0	1.28E-06
Ba-137m	2.09E-10	1.0	1.00E-03	1.0	2.09E-13
Sr-90	7.26E-04	1.0	1.00E-03	1.0	7.26E-07
Y-90	1.84E-07	1.0	1.00E-03	1.0	1.84E-10
Co-60	4.29E-06	1.0	1.00E-03	1.0	4.29E-09
H-3	1.34E-06	1.0	1.00E-03	1.0	1.34E-09
Asbestos	3.52E+03	1.0	1.00E-03	1.0	3.52E+00
Beryllium	2.66E+02	1.0	1.00E-03	1.0	2.66E-01
Cadmium	3.84E+00	1.0	1.00E-03	1.0	3.84E-03
Carbon tetrachloride	8.05E+03	1.0	1.00E-03	1.0	8.05E+00
n-Butyl alcohol	3.99E+00	1.0	1.00E-03	1.0	3.99E-03
Lead	1.06E+04	1.0	1.00E-03	1.0	1.06E+01
Lithium chromate	2.27E+03	1.0	1.00E-03	1.0	2.27E+00
Mercury	2.02E+02	1.0	2.00E-05	1.0	4.04E-03
Methyl alcohol	9.86E+00	1.0	1.00E-03	1.0	9.86E-03
Methylene chloride	5.08E+02	1.0	1.00E-03	1.0	5.08E-01
Nitric acid	2.44E+03	1.0	1.00E-03	1.0	2.44E+00
Nitrates	4.76E+02	1.0	1.00E-03	1.0	4.76E-01
PCB	4.85E+02	0.08	2.00E-05	1.0	7.76E-04
Perchloroethylene	8.02E+02	1.0	1.00E-03	1.0	8.02E-01
1,1,1-trichloroethane	7.46E+03	1.0	1.00E-03	1.0	7.46E+00
Trichloroethylene	5.03E+03	1.0	1.00E-03	1.0	5.03E+00
1,1,2-trichloro-1,2,2-trifluoroethane	4.77E+03	1.0	1.00E-03	1.0	4.77E+00
Xylene	1.97E+01	1.0	1.00E-03	1.0	1.97E-02

Source: BNFL 1998d.

Table E-5.4-4. Source Term for Fire in TRU Waste in the TSA RE.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Pu-241	3.85E-01	0.25	2.14E-04	0.0095	1.96E-07
Am-241	8.76E+00	0.25	2.14E-04	0.0095	4.46E-06
Pu-238	1.67E+00	0.25	2.14E-04	0.0095	8.49E-07
Pu-239	2.73E+02	0.25	2.14E-04	0.0095	1.39E-04
Pu-240	1.73E+01	0.25	2.14E-04	0.0095	8.78E-06
U-233	2.61E+01	0.25	2.14E-04	0.0095	1.33E-05
Cm-244	1.64E-03	0.25	2.14E-04	0.0095	8.34E-10
Cs-134	2.11E-05	0.25	2.14E-04	0.0095	1.07E-11
Cs-137	6.39E-03	0.25	2.14E-04	0.0095	3.25E-09
Ba-137m	1.04E-09	0.25	2.14E-04	0.0095	5.31E-16
Sr-90	3.63E-03	0.25	2.14E-04	0.0095	1.85E-09
Y-90	9.22E-07	0.25	2.14E-04	0.0095	4.68E-13
Co-60	2.18E-05	0.25	2.14E-04	0.0095	1.11E-11
H-3	6.70E-06	0.25	1.00E+00	0.0095	1.59E-08
Asbestos	1.76E+04	0.25	3.50E-03	0.0095	1.46E-01
Beryllium	1.33E+03	0.25	3.50E-03	0.0095	1.10E-02
Cadmium	1.92E+01	0.25	3.50E-03	0.0095	1.60E-04
Carbon tetrachloride	4.02E+04	0.25	3.50E-01	0.0095	3.34E+01
n-Butyl alcohol	2.00E+01	0.25	3.50E-01	0.0095	1.66E-02
Lead	5.30E+04	0.25	3.50E-03	0.0095	4.41E-01
Lithium chromate	1.13E+04	0.25	3.50E-03	0.0095	9.43E-02
Mercury	1.01E+03	0.25	3.50E-01	0.0095	8.40E-01
Methyl alcohol	4.93E+01	0.25	3.50E-01	0.0095	4.10E-02
Methylene chloride	2.54E+03	0.25	3.50E-01	0.0095	2.11E+00
Nitric acid	1.22E+04	0.25	3.50E-02	0.0095	1.01E+00
Nitrates	2.38E+03	0.25	3.50E-02	0.0095	1.98E-01
PCB	2.43E+03	0.25	3.50E-02	0.0095	1.61E-02
Perchloroethylene	4.01E+03	0.25	3.50E-01	0.0095	3.33E+00
1,1,1-trichloroethane	3.73E+04	0.25	3.12E-01	0.0095	2.76E+01
Trichloroethylene	2.52E+04	0.25	3.12E-01	0.0095	1.86E+01
1,1,2-trichloro-1,2,2-trifluoroethane	2.38E+04	0.25	3.12E-01	0.0095	1.76E+01
Xylene	9.83E+01	0.25	3.50E-01	0.0095	8.17E-02
Phosgene[a]	8.63E+04	0.25	4.17E-03	0.0095	8.54E-01
Hydrochloric acid[a]	8.63E+04	0.25	3.50E-02	0.0095	7.17E+00

Source: BNFL 1998d.

a. Phosgene and hydrochloric acid are not in the waste inventory, but are a potential combustion product of chlorinated hydrocarbons.

The RF for a fire in combustible contained, surface-contaminated waste is 1.0 per DOE-HDBK-3010-94, Section 5.2.1.1. The RF for a fire in noncombustible surface-contaminated waste is 0.01 per DOE-HDBK-3010-94, Section 5.3.1. The RF for toxic chemicals is 1.0.

The combined radionuclide ARF and RF for the accident includes the combustible and noncombustible fractions as follows:

ARF x RF = 0.35 (5.0E-04 x 1) + 0.65 (6.0E-03 x 0.01) = 2.14E-04

The accident occurs inside of the TSA-RE. No breach of the enclosure is postulated, and the ventilation, fire detection, and fire suppression systems are assumed to function as designed. It is assumed that 95 percent of particulates from the fire are filtered through HEPA filters with an efficiency of at least 99 percent resulting in a stack release with a LPF of 0.95 x 0.01 = 0.0095. The remaining 5 percent of airborne emissions are assumed to be released unfiltered through doorways and other building penetrations at ground level, resulting in a leak path factor of 0.05 x 1.0 = 0.05. Using the above factors, the source term to the environment can be determined as shown in Table E-5.4-6.

E-5.4.1.7 Fire Involving Waste Transfer Vehicle. The MAR consists of 10 waste boxes each with a volume of 3.2 m^3. It is assumed that all radionuclides and toxic constituents are present at the average concentration in TRU waste at the TSA. The MAR is presented in Table E-5.4-7.

Even in a worst-case fire scenario, it is not reasonable to postulate that all containers on the truck would be involved in a fire. Results of severe fire tests documented in DOE-HDBK-3010-94, Section 7.3.9.2, indicate that only a fraction of containers would be totally breached, some would be only partially breached (lid seal failure), and some would remain intact. Fire suppression activities would also limit spread of the fire. From this information, a bounding DR of 0.25 is estimated.

TRU waste is assumed to be 35 percent combustible and 65 percent noncombustible. The ARF for a fire in combustible contained, surface-contaminated waste is 5.0E-04 per DOE-HDBK-3010-94, Section 5.2.1.1. The ARF for a fire in noncombustible surface contaminated waste is 6.0E-3 per DOE-HDBK-3010-94, Section 5.3.1. The ARF for toxic chemicals is 0.01 for solids, 0.1 for semivolatile liquids, and 1.0 for volatile liquids.

When exposed to heat and flame, all halogenated compounds can be broken down to produce halogenated acids and small quantities of phosgene-type compounds. It is assumed that 89 percent of chlorinated hydrocarbons are volatilized, 10 percent decomposes to hydrochloric acid, and 1 percent are converted to phosgene gas. The phosgene molecular conversion ratio for chlorinated hydrocarbons is approximately 1.19. Therefore, the airborne release fraction for phosgene is 0.0119.

The RF for a fire in combustible contained, surface-contaminated waste is 1.0 per DOE-HDBK-3010-94, Section 5.2.1.1. The RF for a fire in noncombustible surface-contaminated waste is 0.01 per DOE-HDBK-3010-94, Section 5.3.1. The RF for toxic chemicals is 1.0.

The combined radionuclide ARF and RF for the accident includes the combustible and noncombustible fractions as follows:

ARF x RF = 0.35 (5.0E-04 x 1) + 0.65 (6.0E-03 x 0.01) = 2.14E-04.

The accident is assumed to occur outdoors with no confinement. Therefore, the LPF is 1.0. Using the above factors, the source term to the environment can be determined as presented in Table E-5.4-7.

Table E-5.4-5. Source Term for Incinerator Explosion.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Pu-241	1.45E-01	0.1	6.00E-05	1.0	8.67E-07
Am-241	3.29E+00	0.1	6.00E-05	1.0	1.97E-05
Pu-238	6.26E-01	0.1	6.00E-05	1.0	3.76E-06
Pu-239	1.02E+02	0.1	6.00E-05	1.0	6.15E-04
Pu-240	6.48E+00	0.1	6.00E-05	1.0	3.89E-05
U-233	9.78E+00	0.1	6.00E-05	1.0	5.87E-05
Cm-244	6.16E-04	0.1	6.00E-05	1.0	3.69E-09
Cs-134	7.92E-06	0.1	6.00E-05	1.0	4.75E-11
Cs-137	2.40E-03	0.1	6.00E-05	1.0	1.44E-08
Ba-137m	3.92E-10	0.1	6.00E-05	1.0	2.35E-15
Sr-90	1.36E-03	0.1	6.00E-05	1.0	8.17E-09
Y-90	3.46E-07	0.1	6.00E-05	1.0	2.07E-12
Co-60	8.18E-06	0.1	6.00E-05	1.0	4.91E-11
H-3	2.51E-06	0.1	6.00E-05	1.0	1.51E-11
Asbestos	6.59E+03	0.1	6.00E-05	1.0	3.96E-02
Beryllium	4.98E+02	0.1	6.00E-05	1.0	2.99E-03
Cadmium	7.21E+00	0.1	6.00E-05	1.0	4.33E-05
Carbon tetrachloride	1.51E+04	0.1	6.00E-05	1.0	9.05E-02
n-Butyl alcohol	7.49E+00	0.1	6.00E-05	1.0	4.49E-05
Lead	1.99E+04	0.1	6.00E-05	1.0	1.19E-01
Lithium chromate	4.25E+03	0.1	6.00E-05	1.0	2.55E-02
Mercury	3.79E+02	0.1	6.00E-05	1.0	2.27E-03
Methyl alcohol	1.85E+01	0.1	6.00E-05	1.0	1.11E-04
Methylene chloride	9.52E+02	0.1	6.00E-05	1.0	5.71E-03
Nitric acid	4.58E+03	0.1	6.00E-05	1.0	2.75E-02
Nitrates	8.92E+02	0.1	6.00E-05	1.0	5.35E-03
PCB	9.10E+02	0.1	6.00E-05	1.0	5.46E-03
Perchloroethylene	1.50E+03	0.1	6.00E-05	1.0	9.03E-03
1,1,1-trichloroethane	1.40E+04	0.1	6.00E-05	1.0	8.40E-02
Trichloroethylene	9.44E+03	0.1	6.00E-05	1.0	5.66E-02
1,1,2-trichloro-1,2,2-trifluoroethane	8.94E+03	0.1	6.00E-05	1.0	5.36E-02
Xylene	3.69E+01	0.1	6.00E-05	1.0	2.21E-04

Source: BNFL 1998d.

Table E-5.4-6. Source Term for Wind-Borne Missile Breach of Building Structure.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Pu-241	7.71E-02	1.0	1.00E-03	0.1	7.71E-06
Am-241	1.75E+00	1.0	1.00E-03	0.1	1.75E-04
Pu-238	3.34E-01	1.0	1.00E-03	0.1	3.34E-05
Pu-239	5.46E+01	1.0	1.00E-03	0.1	5.46E-03
Pu-240	3.46E+00	1.0	1.00E-03	0.1	3.46E-04
U-233	5.22E+00	1.0	1.00E-03	0.1	5.22E-04
Cm-244	3.28E-04	1.0	1.00E-03	0.1	3.28E-08
Cs-134	4.22E-06	1.0	1.00E-03	0.1	4.22E-10
Cs-137	1.28E-03	1.0	1.00E-03	0.1	1.28E-07
Ba-137m	2.09E-10	1.0	1.00E-03	0.1	2.09E-14
Sr-90	7.26E-04	1.0	1.00E-03	0.1	7.26E-08
Y-90	1.84E-07	1.0	1.00E-03	0.1	1.84E-11
Co-60	4.29E-06	1.0	1.00E-03	0.1	4.29E-10
H-3	1.34E-06	1.0	1.00E-03	0.1	1.34E-10
Asbestos	3.52E+03	1.0	1.00E-03	0.1	3.52E-01
Beryllium	2.66E+02	1.0	1.00E-03	0.1	2.66E-02
Cadmium	3.84E+00	1.0	1.00E-03	0.1	3.84E-04
Carbon tetrachloride	8.05E+03	1.0	1.00E-03	0.1	8.05E-01
n-Butyl alcohol	3.99E+00	1.0	1.00E-03	0.1	3.99E-04
Lead	1.06E+04	1.0	1.00E-03	0.1	1.06E+00
Lithium chromate	2.27E+03	1.0	1.00E-03	0.1	2.27E-01
Mercury	2.02E+02	1.0	2.00E-05	0.1	4.04E-04
Methyl alcohol	9.86E+00	1.0	1.00E-03	0.1	9.86E-04
Methylene chloride	5.08E+02	1.0	1.00E-03	0.1	5.08E-02
Nitric acid	2.44E+03	1.0	1.00E-03	0.1	2.44E-01
Nitrates	4.76E+02	1.0	1.00E-03	0.1	4.76E-02
PCB	4.86E+02	0.08	2.00E-05	0.1	7.78E-04
Perchloroethylene	8.02E+02	1.0	1.00E-03	0.1	8.02E-02
1,1,1-trichloroethane	7.46E+03	1.0	1.00E-03	0.1	7.46E-01
Trichloroethylene	5.03E+03	1.0	1.00E-03	0.1	5.03E-01
1,1,2-trichloro-1,2,2-trifluoroethane	4.77E+03	1.0	1.00E-03	0.1	4.77E-01
Xylene	1.97E+01	1.0	1.00E-03	0.1	1.97E-03

Source: BNFL 1998d.

Table E-5.4-7. Source Term for Fire Involving Waste Transfer Vehicle.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Pu-241	7.71E-01	0.25	2.14E-04	1.0	4.12E-05
Am-241	1.75E+01	0.25	2.14E-04	1.0	9.37E-04
Pu-238	3.34E+00	0.25	2.14E-04	1.0	1.79E-04
Pu-239	5.46E+02	0.25	2.14E-04	1.0	2.92E-02
Pu-240	3.46E+01	0.25	2.14E-04	1.0	1.85E-03
U-233	5.22E+01	0.25	2.14E-04	1.0	2.79E-03
Cm-244	3.28E-03	0.25	2.14E-04	1.0	1.76E-07
Cs-134	4.22E-05	0.25	2.14E-04	1.0	2.26E-09
Cs-137	1.28E-02	0.25	2.14E-04	1.0	6.84E-07
Ba-137m	2.09E-09	0.25	2.14E-04	1.0	1.12E-13
Sr-90	7.26E-03	0.25	2.14E-04	1.0	3.89E-07
Y-90	1.84E-06	0.25	2.14E-04	1.0	9.86E-11
Co-60	4.36E-05	0.25	2.14E-04	1.0	2.33E-09
H-3	1.34E-05	0.25	2.14E-04	1.0	7.17E-10
Asbestos	3.52E+04	0.25	3.50E-03	1.0	3.08E+01
Beryllium	2.66E+03	0.25	3.50E-03	1.0	2.33E+00
Cadmium	3.84E+01	0.25	3.50E-03	1.0	3.36E-02
Carbon tetrachloride	8.05E+04	0.25	3.50E-01	1.0	7.04E+03
n-Butyl alcohol	3.99E+01	0.25	3.50E-01	1.0	3.49E+00
Lead	1.06E+05	0.25	3.50E-03	1.0	9.28E+01
Lithium chromate	2.27E+04	0.25	3.50E-03	1.0	1.99E+01
Mercury	2.02E+03	0.25	3.50E-01	1.0	1.77E+02
Methyl alcohol	9.86E+01	0.25	3.50E-01	1.0	8.63E+00
Methylene chloride	5.08E+03	0.25	3.50E-01	1.0	4.44E+02
Nitric acid	2.44E+04	0.25	3.50E-02	1.0	2.14E+02
Nitrates	4.76E+03	0.25	3.50E-02	1.0	4.16E+01
PCB	4.85E+03	0.25	3.50E-02	1.0	3.40E+00
Perchloroethylene	8.02E+03	0.25	3.50E-01	1.0	7.02E+02
1,1,1-trichloroethane	7.46E+04	0.25	3.12E-01	1.0	5.81E+03
Trichloroethylene	5.03E+04	0.25	3.12E-01	1.0	3.92E+03
1,1,2-trichloro-1,2,2-trifluoroethane	4.77E+04	0.25	3.12E-01	1.0	3.71E+03
Xylene	1.97E+02	0.25	3.50E-01	1.0	1.72E+01
Phosgene[a]	1.73E+05	0.25	4.17E-03	1.0	1.80E+02
Hydrochloric acid[a]	1.73E+05	0.25	3.50E-02	1.0	1.51E+03

Source: BNFL 1998d.
[a.] Phosgene and hydrochloric acid are not in the waste inventory, but are a potential combustion product of chlorinated hydrocarbons.

E-5.4.1.8 Vitrifier Explosion. The radionuclide content in the vitrifier is limited by criticality considerations. The MAR assumes that there is one kilogram of Pu-239 equivalent in the 18,000 kg of material in the vitrifier at the time of the explosion. It is assumed that all radionuclides are present at the average concentration in TRU waste at the TSA. Other MAR that could be released in the explosion (loading on vitrifier offgas system filters, feed auger) is considered insignificant compared to the vitrifier. It is also assumed that the majority of significant toxic compounds will have been removed from the MAR in the incineration process preceding vitrification. The MAR is presented in Table E-5.4-8.

An explosion DR of 0.1 is estimated for the material in the vitrifier. The ARF for molten glass is 6.0E-03 per DOE-HDBK-3010-94, Section 4.2.1.2.2. The ARF for any “cold cap” ash is also 6.0E-03 per DOE-HDBK-3010-94, Section 4.4.1.1. The RF is 1.0 based on DOE-HDBK-3010-94, Section 4.2.1.2.2.

Table E-5.4-8. Source Term for Vitrifier Explosion.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Pu-241	2.88E+00	0.1	6.00E-03	1.0	1.73E-03
Am-241	5.48E-01	0.1	6.00E-03	1.0	3.29E-04
Pu-238	6.27E-01	0.1	6.00E-03	1.0	3.76E-04
Pu-239	9.08E+02	0.1	6.00E-03	1.0	5.45E-01
Pu-240	1.29E+00	0.1	6.00E-03	1.0	7.75E-04
U-233	8.67E+01	0.1	6.00E-03	1.0	5.20E-02
Cm-244	4.91E-04	0.1	6.00E-03	1.0	2.95E-07
Cs-134	6.33E-05	0.1	6.00E-03	1.0	3.80E-08
Cs-137	1.92E-02	0.1	6.00E-03	1.0	1.15E-05
Ba-137m	3.13E-09	0.1	6.00E-03	1.0	1.88E-12
Sr-90	1.09E-02	0.1	6.00E-03	1.0	6.54E-06
Y-90	2.76E-06	0.1	6.00E-03	1.0	1.66E-09
Co-60	6.54E-05	0.1	6.00E-03	1.0	3.93E-08
H-3	2.01E-05	0.1	6.00E-03	1.0	1.21E-08

Source: BNFL 1998d.

The explosion is assumed to cause failure of the vitrifier cell and the roof above the vitrifier cell and/or the adjacent building doors. Therefore, a LPF of 1.0 is conservatively assumed. Using the above factors, the source term to the environment can be determined as shown in Table E-5.4-8.

E-5.4.1.9 Type II Storage Module Fire. The maximum transuranic waste storage capacity of one Type II module is 19,320 drums or 2,640 boxes. However, the normal storage configuration in each Type II module includes a combination of drums and boxes. An inventory of approximately 90 percent drums (11,040) and 10 percent boxes (1056) is used based on the average distribution of TRU waste container types and the Type II module storage configuration. The total MAR is 5698 cubic meters. It is assumed that all radionuclides and toxic constituents are present at the average concentration in TRU waste at the TSA. The MAR is presented in Table E-5.4-9.

Combustible materials within the facility are kept at a minimum, and all waste is in containers. Even in a worst-case fire scenario, it is not reasonable to postulate that all containers on the truck would be involved in a fire. Results of severe fire tests documented in DOE-HDBK-3010-94, Section 7.3.9.2, indicate that only a fraction of containers would be totally breached, some would be only partially breached (lid seal failure), and some would remain intact. Fire suppression activities would also limit spread of the fire. From this information, a bounding DR of 0.25 is estimated.

TRU waste is assumed to be 35 percent combustible and 65 percent noncombustible. The ARF for a fire in combustible contained, surface-contaminated waste is 5.0E-04 per DOE-HDBK-3010-94, Section 5.2.1.1. The ARF for a fire in noncombustible surface contaminated waste is 6.0E-3 per DOE-HDBK-3010-94, Section 5.3.1. The ARF for toxic chemicals is 0.01 for solids, 0.1 for semivolatile liquids, and 1.0 for volatile liquids.

When exposed to heat and flame, all halogenated compounds can be broken down to produce halogenated acids and small quantities of phosgene-type compounds. It is assumed that 89 percent of chlorinated hydrocarbons are volatilized, 10 percent decomposes to hydrochloric acid, and 1 percent are converted to phosgene gas. The phosgene molecular conversion ratio for chlorinated hydrocarbons is approximately 1.19. Therefore, the airborne release fraction for phosgene is 0.0119.

The RF for a fire in combustible contained, surface-contaminated waste is 1.0 per DOE-HDBK-3010-94, Section 5.2.1.1. The RF for a fire in noncombustible surface-contaminated waste is 0.01 per DOE-HDBK-3010-94, Section 5.3.1. The RF for toxic chemicals is 1.0.

The combined radionuclide ARF and RF for the accident includes the combustible and noncombustible fractions as follows:

$$ARF \times RF = 0.35\,(5.0E\text{-}04 \times 1) + 0.65\,(6.0E\text{-}03 \times 0.01) = 2.14E\text{-}04.$$

Major failure of the building structure is assumed to occur. Therefore, the LPF is 1.0. Using the above factors, the source term to the environment can be determined as presented in Table E-5.4-9.

Table E-5.4-9. Source Term for Type II Storage Module Fire.

Nuclide/Chemical	MAR, g	DR	ARF x RF	LPF	Source, g
Am-241	3.12E+03	0.25	2.14E-04	1.0	1.67E-01
Ba-137m	3.72E-07	0.25	2.14E-04	1.0	1.99E-11
Cm-244	5.85E-01	0.25	2.14E-04	1.0	3.13E-05
Co-60	7.77E-03	0.25	2.14E-04	1.0	4.16E-07
Cs-134	7.52E-03	0.25	2.14E-04	1.0	4.02E-07
Cs-137	2.28E+00	0.25	2.14E-04	1.0	1.22E-04
H-3	2.39E-03	0.25	2.14E-04	1.0	1.28E-07
Pu-238	5.95E+02	0.25	2.14E-04	1.0	3.18E-02
Pu-239	9.73E+04	0.25	2.14E-04	1.0	5.20E+00
Pu-240	6.15E+03	0.25	2.14E-04	1.0	3.29E-01
Pu-241	1.37E+02	0.25	2.14E-04	1.0	7.34E-03
Sr-90	1.29E+00	0.25	2.14E-04	1.0	6.92E-05
U-233	9.29E+03	0.25	2.14E-04	1.0	4.97E-01
Y-90	3.28E-04	0.25	2.14E-04	1.0	1.76E-08
Asbestos	6.26E+06	0.25	3.50E-03	1.0	5.48E+03
Barium	0.00E+00	0.25	1.00E-02	1.0	0.00E+00
Beryllium	4.73E+05	0.25	3.50E-03	1.0	4.14E+02
Cadmium	6.85E+03	0.25	3.50E-03	1.0	5.99E+02
Carbon tetrachloride	1.43E+07	0.25	3.50E-01	1.0	1.25E+06
Chromium	0.00E+00	0.25	1.00E-02	1.0	0.00E+00
n-Butyl alcohol	7.11E+03	0.25	3.50E-01	1.0	6.22E+02
Ether	0.00E+00	0.25	1.00E+00	1.0	0.00E+04
Lead	1.89E+07	0.25	3.50E-03	1.0	1.65E+04
Hydrochloric acid	0.00E+00	0.25	1.00E-01	1.0	0.00E+00
Lithium chromate	4.04E+06	0.25	3.50E-03	1.0	3.54E+03
Mercury	3.60E+05	0.25	3.50E-01	1.0	3.15E+04
Methyl alcohol	1.76E+04	0.25	3.50E-01	1.0	1.54E+03
Methylene chloride	9.04E+05	0.25	3.50E-01	1.0	7.91E+04
Nitric acid	4.34E+06	0.25	3.50E-02	1.0	3.80E+04
Nitrates	8.47E+05	0.25	3.50E-02	1.0	7.41E+03
Nitrobenzene	0.00E+00	0.25	1.00E-01	1.0	0.00E+00
PCB	8.64E+05	0.02	3.50E-02	1.0	6.05E+02
Perchloroethylene	1.43E+06	0.25	3.50E-01	1.0	1.25E+05
Selenium	0.00E+00	0.25	1.00E-02	1.0	0.00E+00
Silver	0.00E+00	0.25	1.00E-02	1.0	0.00E+00
Sodium Chromate	0.00E+00	0.25	1.00E-01	1.0	0.00E+00
1,1,1-trichloroethane	1.33E+07	0.25	3.12E-01	1.0	1.04E+06
Trichloroethylene	8.96E+06	0.25	3.12E-01	1.0	6.98E+05
1,1,2-trichloro-1,2,2-trifluoroethane	8.49E+06	0.25	3.12E-01	1.0	6.61E+05
Xylene	3.50E+04	0.25	3.50E-01	1.0	3.06E+03
Phosgene[a]	3.07E+07	0.25	4.17E-03	1.0	3.20E+04
Hydrochloric acid[a]	3.07E+07	0.25	3.50E-02	1.0	2.69E+05

Source: BNFL 1998d.

a. Phosgene and hydrochloric acid are not in the waste inventory, but are a potential combustion product of chlorinated hydrocarbons.

E-5.4.2 Meteorological Parameters

Meteorological conditions assumed at the time of release impact the calculation by RSAC-5 of diffusion, dispersion, and depletion factors. Except for releases through operable discharge systems such as offgas filtration and ventilation systems, most releases are assumed to be at ground level. The ground-level release assumption is conservative because the slower dispersion compared to elevated releases results in higher ground-level concentrations and, in the case of radiological releases, higher estimates of radiation exposures near the point of release.

The F stability class was selected since it is the conservative stability class which minimizes dispersion, thereby maximizing downwind concentrations. Similarly, a low windspeed of 1.0 m/s is used for the same reasons. The RSAC-5 program has three different models for diffusion coefficients. For short duration releases (20 minutes or less), the Hilsmeier-Gifford model is used to determine diffusion coefficients as a function of downwind distance. For long duration releases (one hour or longer), the Markee model is used.

Downwind chemical concentrations and radiation exposures are determined at distances of 100 meters, 3,000 meters, and 6,000 meters. The receptor at 100 meters represents a co-located facility worker within the RWMC area. The 3,000 meters receptor represents the distance to the Experimental Breeder Reactor (EBR-I) National Historical Site where members of the public may be present. The receptor at 6,000 meters represents the distance to the nearest site boundary south of the RWMC.